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DCAS-TDR-62-2

REPORT NO.
TDR-930(2210-07)TN-1

18

Propellant Performance and Gas Composition Handbook

3 JANUARY 1962

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Prepared for DEPUTY COMMANDER AEROSPACE SYSTEMS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Inglewood, California

LABORATORIES DIVISION • AEROSPACE CORPORATION

CONTRACT NO. AF 04(647)-930

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ABSTRACT

Performance tables are presented which were obtained by plotting data from machine calculations and interpolating to obtain vacuum specific impulses for integral values of the area ratio. The values are convenient reference points for the calculation of interpolated values of the specific impulse for any given area ratio. Tables of gas compositions and performances are also included in this handbook.

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INTRODUCTION

The performance tables in this manual were developed to meet the needs of engineers and systems analysts who frequently need to know the potential performance of a rocket engine with a specific area ratio and operating in a given ambient pressure.

The usual machine-calculated values for performance are obtained by fixing the pressure ratio and calculating the corresponding area ratio and specific impulse for expansion into a vacuum. The accompanying tables were obtained by carefully plotting data from machine calculations and interpolating to obtain vacuum specific impulses for integral values of the area ratio. These area ratio values thus become convenient reference points for the calculation of interpolated values of the specific impulse for any given area ratio.

As indicated in the theoretical discussion, the calculations involve simple arithmetic and can be made in a very short time.

It should be emphasized that I_v (vacuum specific impulse), as defined herein, is the theoretical impulse obtained for a motor with a given area ratio operating in a vacuum. The vacuum specific impulse is not the theoretical maximum specific impulse (corresponding to an infinite area ratio) for expansion into a vacuum.

All propellants are considered to be liquids at either ambient temperature or their boiling point, whichever is lower.

When interpolating for chamber pressures, it is useful to note that I_s is approximately proportional to log P_c.

Linear interpolation for I_v is unsatisfactory for small values of ϵ since the curve is definitely nonlinear in this region, and calculated values will be from one to two seconds too low. If greater accuracy is required, a few points should be plotted and the appropriate value of I_v obtained from the curve.

NOMENCLATURE

A_e = area at exit (sq in.)

A_t = area at throat (sq in.)

c = effective exhaust velocity (ft/sec)

c^* = characteristic velocity (ft/sec)

C_f = nozzle coefficient

C_v = vacuum nozzle coefficient

ϵ = area ratio = A_e/A_t

F = thrust (lb)

g = acceleration of gravity (32.2 ft/sec^2)

ΔI = $I_v - I_s$

I_s = specific impulse (sec)

I_v = vacuum specific impulse (specific impulse for operation in a vacuum); i.e., when $P_a = 0$

P_a = ambient pressure (lb/sq in.)

P_c = chamber pressure (lb/sq in.)

P_e = pressure at exit (lb/sq in.)

r = mixture ratio = weight oxidizer/weight fuel

v_e = true velocity of efflux (ft/sec)

$\dot{w}$ = weight flow rate (lb/sec)

DIRECTIONS FOR THE USE OF PERFORMANCE TABLES

If ϵ and P_a are given, and I_s is desired;

1. Determine I_v and $\frac{\Delta I}{\epsilon P_a}$ from the table or by interpolation

2. Calculate $\Delta I = \epsilon\ P_a \times \frac{\Delta I}{\epsilon P_a}$

3. Then, $I_s = I_v - \Delta I$

4. For the optimum value of I_s at a given P_a, locate the value of P_e corresponding to the given P_a and also determine from the table the corresponding value of ϵ. Using the value of $P_e = P_a$ and the corresponding value of ϵ, determine the value of I_s as above. The value so obtained is a maximum for the given value of P_a.

   Values of P_e may be readily interpolated since log P_c/P_e is proportional to log ϵ.

5. The method of calculation of c*, c, C_f, C_v, and v_e is shown in the sample calculation which follows the discussion of the theory.

THEORY

The basic equation for rocket thrust is

$$F = \frac{\dot{w} v_e}{g} + (P_e - P_a) A_e \qquad (1)$$

Newton's second law requires that

$$F = \frac{\dot{w}\, c}{g} \qquad (2)$$

Specific impulse is defined as pounds of thrust per pound per second of propellant consumption. Therefore,

$$I_s = \frac{F}{\dot{w}} \qquad (3)$$

Combining (1), (2), and (3) we obtain

$$I_s = \frac{c}{g} = \frac{F}{\dot{w}} = \frac{v_e}{g} + \frac{(P_e - P_a) A_e}{\dot{w}} \qquad (4)$$

Letting $P_a = 0$, we obtain

$$I_v = \frac{v_e}{g} + \frac{P_e A_e}{\dot{w}} \qquad (5)$$

NOTE: Maximum I_s for a given value of P_a is obtained when $P_e = P_a$

Subtracting (5) from (4)

$$I_s = I_v - \frac{P_a A_e}{\dot{w}} \qquad (6)$$

By definition,

$$c^* = \frac{P_c A_t g}{\dot{w}} \tag{7}$$

Solving (7) for $\dot{w}$ and substituting in (6), we obtain

$$I_s = I_v - \frac{A_e}{A_t} \cdot \frac{P_a}{P_c} \cdot \frac{c^*}{g} \tag{8}$$

But

$$\epsilon = \frac{A_e}{A_t} \text{ (definition)} \tag{9}$$

Substituting (9) in (8)

$$I_s = I_v - \frac{\epsilon P_a c^*}{P_c g} \tag{10}$$

Let

$$\Delta I = I_v - I_s = \frac{\epsilon P_a c^*}{P_c g} \tag{11}$$

or

$$\frac{\Delta I}{\epsilon P_a} = \frac{c^*}{P_c g} \tag{12}$$

Equation (12) is used to calculate the values of $\frac{\Delta I}{\epsilon P_a}$ shown in the tables.

Then

$$I_s = I_v - \Delta I$$

or

$$I_s = I_v - \epsilon P_a \left(\frac{\Delta I}{\epsilon P_a}\right) \tag{13}$$

Since ϵ and P_a are known and $\frac{\Delta I}{\epsilon P_a}$ is given in the table, the calculation of I_s is simple.

<u>To Find c^*, c, C_f, and C_v</u>

Solving (11) for c^* we obtain

$$c^* = \left(\frac{\Delta I}{\epsilon P_a}\right) P_c g \tag{14}$$

Since the value of $\frac{\Delta I}{\epsilon P_a}$ is given in the table, c^* is readily obtained by the use of Equation (14).

From Equation (4),

$$c = I_s \cdot g \tag{15}$$

By definition,

$$C_f = \frac{F}{P_c A_t} \tag{16}$$

Combining Equations (3), (7), and (16) we obtain

$$C_f = \frac{c}{c^*} = \frac{I_s g}{c^*} \tag{17}$$

Therefore,

$$C_v = \frac{I_v g}{c^*} \tag{18}$$

Combining (17) and (18)

$$C_v = C_f \cdot \frac{I_v}{I_s} \tag{19}$$

From Equation (6)

$$I_v - I_s = \frac{P_a A_e}{\dot{w}} = \Delta I \tag{20}$$

From Equations (5) and (6)

$$\frac{v_e}{g} = I_s - \frac{A_e}{\dot{w}} (P_e - P_a) \tag{21}$$

From Equation (20)

$$\frac{A_e}{\dot{w}} = \frac{\Delta I}{P_a} \tag{22}$$

Substituting (22) in (21)

$$v_e = g \left[I_s - \frac{\Delta I}{P_a} \cdot (P_e - P_a) \right] \tag{23}$$

Since $\frac{\Delta I}{\epsilon P_a}$ is given in the tables, it is more convenient to rearrange Equation (23) as follows:

$$v_e = g \left[I_s - \epsilon \left(\frac{\Delta I}{\epsilon P_a} \right) (P_e - P_a) \right] \tag{24}$$

Using Equation (24) and the data obtained in the example, we obtain

$$v_e = 32.2 \left[395.7 - 20 \times 2.189 \, (0.52 - 0.20) \right]$$

$$v_e = \underline{12,291} \text{ ft/sec}$$

Note that the value of c, the effective exhaust velocity, was 12,742 ft/sec.

EXAMPLE

Given $\epsilon = 20$ and $r = 2.00$

$$P_a = 0.20 \text{ and } P_c = 100$$

From table,

$$I_v = 404.5 \text{ sec}$$

From table,

$$\frac{\Delta I}{\epsilon P_a} = 2.189$$

By Equation (13),

$$I_s = 404.5 - 20 \times 0.20 \times 2.189$$

$$= \underline{395.7 \text{ sec}}$$

Also

By Equation (14),

$$c^* = 2.189 \times 100 \times 32.2 = 7049 \text{ ft/sec}$$

By Equation (15),

$$c = 395.7 \times 32.2 = 12{,}742 \text{ ft/sec}$$

By Equation (17),

$$C_f = \frac{12{,}742}{7049} = 1.808$$

By Equation (19),

$$C_v = 1.808 \times \frac{404.5}{395.7}$$

$$= 1.848$$

<u>To Obtain Maximum I_s for P_a = 0.20</u>

Set $P_e = P_a = 0.20$

From table, corresponding value of ϵ is 40

Calculate I_s as above; i.e.,

$$I_v = 418.0 \text{ sec}$$

$$I_s = 418 - 40 \times 0.20 \times 2.189$$

$$= \underline{400.5 \text{ sec}}$$

This value might also have been obtained by plotting calculated values of I_s (for P_a = 0.20) as a function of ϵ. At the maximum value of I_s, the corresponding ϵ is optimum and P_e must equal P_a.

For example, for P_a = 0.20 psia and r = 2.00

ϵ	ΔI	I_v	I_s
10	4.4	386.7	382.3
15	6.6	397.4	390.8
20	8.8	404.5	395.7
25	10.9	409.2	398.3
30	13.1	412.8	399.7
40	17.5	418.0	400.5 (max)
50	21.9	421.5	399.6

As determined previously, the value of I_s is optimum at ϵ = 40 and is 400.5 sec.

It is of theoretical interest to calculate the value of v_e in order to compare v_e with c, which is the effective exhaust velocity.

PERFORMANCE - OXYGEN AND N_2O_4 SYSTEMS

RP-1 - Oxygen

Shifting Equilibrium

$P_c = 150$

P_e	r = 2.10		r = 2.20		r = 2.30		r = 2.40		r = 2.50	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	232.2	2.36	232.7	2.40	232.6	2.43	232.2	2.45	231.4	2.47
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	266.8	18.20	268.5	18.85	266.0	18.90	266.0	18.75	265.0	19.15
6	306.5	3.83	307.3	3.99	308.3	4.03	308.0	4.31	307.3	4.40
10	319.7	1.88	321.5	2.00	322.4	2.08	323.3	2.20	323.0	2.28
12	323.4	1.44	325.6	1.59	326.8	1.63	327.7	1.73	327.7	1.85
14	326.3	1.19	328.8	1.29	330.3	1.32	331.4	1.43	331.6	1.51
16	329.0	1.00	331.6	1.09	333.2	1.10	334.4	1.18	334.8	1.29
20	333.4	0.78	336.2	0.78	337.8	0.87	339.4	0.88	339.9	0.93
25	337.4	0.52	340.3	0.52	342.2	0.62	344.5	0.62	345.0	0.69
30	340.0	0.40	343.4	0.40	345.4	0.50	348.0	0.50	349.1	0.53
40	344.1	0.30	348.0	0.30	350.5	0.34	352.6	0.38	354.0	0.40
50	347.4	0.21	351.3	0.21	353.9	0.28	356.3	0.29	357.5	0.30
$\Delta I/_{\epsilon} P_a$	1.213		1.213		1.211		1.207		1.202	

<u>RP-1 - Oxygen</u>

<u>Shifting Equilibrium</u>

$P_c = 300$

P_e	r = 2.10		r = 2.20		r = 2.30		r = 2.40		r = 2.50	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	259.3	3.73	260.5	3.82	261.2	3.91	261.2	3.99	4.05	260.7
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	269.0	32.05	270.0	33.85	270.0	33.95	270.0	36.05	267.5	36.0
6	307.0	7.27	308.9	7.60	309.5	8.10	310.3	8.30	309.3	8.55
10	322.0	3.65	322.7	3.85	324.2	4.05	324.7	4.18	325.2	4.38
12	323.8	2.89	326.7	3.05	328.5	3.18	329.4	3.32	329.7	3.48
14	327.0	2.38	329.9	2.50	331.8	2.59	333.2	2.70	333.3	2.81
16	329.5	2.00	332.4	2.09	334.7	2.19	336.2	2.25	336.3	2.35
20	333.6	1.50	336.6	1.55	339.3	1.61	340.8	1.69	341.2	1.78
25	337.4	1.10	340.6	1.14	343.8	1.20	345.2	1.28	346.3	1.35
30	340.4	0.88	343.7	0.89	347.0	0.98	348.6	0.99	350.0	1.09
40	344.9	0.60	348.2	0.61	351.1	0.62	353.3	0.65	355.0	0.75
50	347.9	0.48	351.5	0.50	354.6	0.50	356.9	0.50	358.6	0.50
$\Delta I/_{\epsilon} P_a$	0.610		0.611		0.610		0.608		0.606	

RP-1 - Liquid Oxygen

Shifting Equilibrium

$P_c = 500$

P_e	r = 2.20		r = 2.30		r = 2.40		r = 2.50		r = 2.60	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	277.5	5.44	278.7	5.59	279.2	5.73	279.2	5.87	278.7	5.97
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
5	304.0	16.20	305.0	17.30	305.9	17.80	305.0	18.10	304.6	18.50
7	313.8	10.20	315.0	10.80	315.8	11.15	315.6	11.50	315.6	12.05
10	323.0	6.25	324.6	6.58	325.8	6.95	326.0	7.15	326.2	7.40
12	327.0	4.95	329.0	5.15	330.2	5.40	330.7	5.75	331.4	5.80
14	330.2	4.05	332.3	4.29	334.1	4.45	334.4	4.75	334.8	4.80
16	332.7	3.40	335.0	3.65	337.0	3.75	337.7	3.95	337.9	4.05
20	337.6	2.53	339.6	2.68	341.4	2.78	342.6	2.95	342.8	3.05
25	341.8	1.90	344.2	2.00	345.6	2.08	347.0	2.19	347.5	2.30
30	344.7	1.50	347.5	1.60	349.0	1.65	350.6	1.70	351.0	1.85
40	348.4	1.01	351.9	1.10	356.2	1.15	358.4	1.19	369.9	1.25
50	353.8	0.77	357.4	0.80	357.8	0.83	360.0	0.90	361.5	0.96
$\Delta I/_{\epsilon} P_a$	0.368		0.368		0.367		0.365		0.364	

RP-1 - Liquid Oxygen

Shifting Equilibrium

$P_c = 1000$

P_e	r = 2.20		r = 2.30		r = 2.40		r = 2.50		r = 2.60	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	296.7	8.88	298.7	9.14	300.0	9.41	300.7	9.70	300.8	9.98
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
8	318.2	16.95	319.8	17.50	321.0	18.20	321.6	18.90	321.5	19.50
10	323.8	12.55	325.8	12.90	327.4	13.55	327.8	14.10	327.5	14.55
12	327.5	9.67	330.0	10.18	331.5	10.55	332.6	11.05	332.4	11.43
14	330.6	7.85	333.0	8.29	334.7	8.55	335.9	8.95	336.2	9.35
16	333.3	6.65	335.8	6.95	337.6	7.25	338.8	7.50	339.6	7.86
18	335.7	5.75	338.5	6.00	340.0	6.30	341.4	6.48	342.1	6.80
20	338.0	4.95	340.4	5.24	342.2	5.52	343.6	5.67	344.4	6.00
25	342.0	3.60	344.7	3.80	346.8	3.98	348.2	4.20	349.0	4.49
30	345.0	2.88	347.8	3.02	350.2	3.16	351.6	3.38	352.4	3.60
40	349.2	2.00	352.4	2.10	354.8	2.20	356.7	2.35	358.1	2.44
50	352.2	1.53	355.8	1.59	358.5	1.65	360.5	1.75	361.8	1.86
$\Delta I / \epsilon P_a$	0.185		0.185		0.185		0.184		0.184	

RP-1 - Liquid Oxygen

Shifting Equilibrium

$P_c = 700$

P_e	r = 2.20		r = 2.30		r = 2.40		r = 2.50		r = 2.60	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	287.3	6.89	288.9	7.08	289.8	7.29	290.1	7.49	289.9	7.67
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
5	304.6	22.30	306.2	23.65	306.6	24.50	305.8	25.50	305.6	25.60
7	314.3	14.20	316.2	14.65	317.0	15.40	317.2	15.80	316.2	16.00
10	323.4	8.75	325.4	9.09	326.7	9.49	327.0	9.90	327.1	10.20
12	327.2	6.95	329.6	7.18	330.7	7.52	331.4	7.85	331.8	8.12
14	330.2	5.61	332.4	5.85	334.1	6.28	335.4	6.55	335.9	6.75
16	332.8	4.68	335.6	4.85	337.0	5.27	338.4	5.45	339.1	5.74
20	339.4	3.51	340.2	3.67	341.8	3.87	343.2	4.01	343.8	4.22
25	341.6	2.61	344.4	2.70	346.5	2.89	347.6	2.97	348.4	3.11
30	346.6	2.10	347.6	2.18	349.9	2.30	351.0	2.39	351.9	3.00
40	351.0	1.49	351.9	1.50	354.4	1.60	356.2	1.66	357.5	1.72
50	352.3	1.08	355.5	1.12	358.1	1.16	360.0	1.24	361.2	1.33
$\Delta I / \epsilon P_a$	0.264		0.264		0.263		0.262		0.261	

Hydrazine-Oxygen

Shifting Equilibrium

$P_c = 150$

P_e	r = 0.500		r = 0.600		r = 0.700		r = 0.800		r = 0.900	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	238.1	2.19	242.7	2.24	245.0	2.31	245.4	2.39	243.7	2.44
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	275.0	16.00	280.0	17.40	283.0	18.20	282.5	19.20	279.5	18.65
4	299.3	5.70	305.8	5.99	309.5	6.53	310.7	6.68	309.0	7.23
7	313.4	2.58	320.8	2.73	326.3	2.83	328.3	3.12	328.3	3.43
10	320.9	1.52	329.2	1.63	334.9	1.78	337.5	1.88	338.5	2.11
12	324.3	1.19	332.7	1.30	338.5	1.38	342.3	1.43	343.2	1.63
16	329.1	0.79	338.3	0.88	344.2	0.90	348.6	1.01	349.9	1.08
20	332.6	0.59	342.1	0.59	349.4	0.62	353.0	0.71	354.8	0.80
25	335.6	0.40	345.5	0.40	352.0	0.43	357.1	0.51	359.5	0.51
30	337.8	0.31	347.9	0.32	355.0	0.34	360.1	0.40	362.7	0.40
40	341.1	0.20	351.4	0.20	359.4	0.30	364.9	0.30	367.4	0.30
50	343.0	0.12	353.6	0.12	362.1	0.20	367.7	0.20	371.1	0.20
$\Delta I/_{\epsilon} P_a$	1.254		1.276		1.283		1.280		1.268	

Hydrazine - Liquid Oxygen

Shifting Equilibrium

$P_c = 300$

P_e	r = 0.50		r = 0.60		r = 0.70		r = 0.80		r = 0.90	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	263.0	3.41	268.9	3.51	272.7	3.63	274.3	3.79	273.8	3.95
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
3	290.4	16.40	297.1	17.15	300.8	17.85	301.4	19.60	299.6	21.25
6	309.6	6.20	317.4	6.75	321.8	7.15	325.0	7.75	324.6	8.45
10	321.0	3.10	329.4	3.25	335.4	3.48	338.7	3.75	340.0	4.05
12	324.4	2.44	333.1	2.52	339.5	2.75	343.0	2.98	344.4	3.18
14	327.1	1.95	335.9	2.02	342.4	2.23	346.2	2.41	347.9	2.58
16	329.2	1.58	338.2	1.68	344.8	1.88	348.8	2.00	350.9	2.18
20	332.4	1.10	341.9	1.21	348.8	1.36	353.6	1.48	355.8	1.60
25	335.6	0.80	345.2	0.89	352.6	1.00	357.6	1.09	360.4	1.20
30	338.0	0.62	347.7	0.69	355.3	0.80	360.7	0.80	363.7	0.92
40	341.2	0.41	351.6	0.48	359.2	0.50	364.9	0.54	368.2	0.65
50	343.5	0.32	354.2	0.35	362.3	0.38	368.1	0.43	371.9	0.47
$\Delta I / \epsilon P_a$	0.627		0.639		0.644		0.644		0.638	

Hydrazine - Liquid Oxygen

Shifting Equilibrium

P_c = 500

P_e	r = 0.60		r = 0.70		r = 0.80		r = 0.90		r = 1.00	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	284.7	4.96	289.3	5.14	291.9	5.36	292.3	5.64	289.8	5.84
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
5	312.0	14.30	317.4	15.20	319.8	16.20	320.4	17.05	317.0	17.95
7	321.4	9.00	327.1	9.45	330.3	10.15	330.4	10.99	328.2	11.40
10	329.6	5.39	334.8	5.75	339.6	6.12	340.8	6.72	338.7	7.18
12	333.1	4.13	339.4	4.45	343.5	4.88	345.4	5.25	343.5	5.68
14	335.8	3.35	342.2	3.56	346.7	3.99	348.8	4.35	347.2	4.68
16	338.2	2.79	344.8	2.98	349.4	3.30	351.6	3.60	350.3	3.95
20	341.9	2.08	349.2	2.20	353.9	2.41	356.6	2.65	355.6	2.93
25	345.4	1.51	352.8	1.60	358.1	1.81	361.1	2.01	360.3	2.19
30	348.0	1.20	355.6	1.25	361.2	1.42	364.2	1.59	363.9	1.73
40	351.6	0.80	359.9	0.90	365.2	0.99	368.8	1.10	369.3	1.19
50	354.3	0.58	362.5	0.63	368.5	0.70	372.4	0.78	373.2	0.88
$\Delta I/_{\epsilon} P_a$	0.384		0.388		0.388		0.385		0.380	

Hydrazine-Oxygen

Shifting Equilibrium

$P_c = 700$

P_e	r = 0.600		r = 0.700		r = 0.800		r = 0.900		r = 1.000	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	293.7	6.25	298.9	6.49	302.1	6.77	303.1	7.15	301.1	7.48
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
4	305.7	26.25	310.8	29.25	313.2	30.52	313.2	32.25	309.8	33.48
7	321.2	12.53	327.3	13.18	330.7	13.98	331.4	15.20	328.9	16.25
10	329.7	7.49	335.7	8.05	339.7	8.53	341.4	9.18	339.5	9.98
12	333.6	5.78	339.5	6.38	343.9	6.67	345.6	7.75	344.3	7.82
14	336.4	4.71	342.5	5.15	347.4	5.51	349.3	5.89	347.7	6.45
16	338.6	3.93	345.3	4.22	350.2	4.75	352.2	4.95	350.9	5.48
20	341.9	2.88	349.4	3.08	354.4	3.32	357.0	3.65	356.2	4.15
25	345.3	2.10	353.0	2.29	358.3	2.38	361.5	2.75	361.2	2.95
30	347.9	1.61	355.6	1.77	361.0	1.89	364.6	2.15	364.7	2.29
40	351.6	1.01	359.8	1.20	365.6	1.28	369.4	1.49	369.7	1.61
50	354.4	0.80	362.6	0.90	368.5	0.90	372.6	1.20	373.6	1.21
$\Delta I / \epsilon P_a$	0.274		0.277		0.278		0.276		0.273	

Hydrazine - Liquid Oxygen
Shifting Equilibrium
$P_c = 1000$

P_e	r = 0.600		r = 0.700		r = 0.800		r = 0.900		r = 1.00	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	302.3	8.01	308.0	8.33	311.8	8.71	313.5	9.20	312.0	9.73
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
7	321.8	17.75	327.5	18.80	331.4	19.45	331.9	21.30	329.8	22.40
10	329.9	10.74	336.0	11.25	340.2	12.20	341.8	13.08	340.2	14.15
12	333.4	8.25	340.0	8.75	344.3	9.38	346.4	10.38	345.2	11.15
14	336.0	6.69	343.0	7.09	347.5	7.50	349.6	8.39	348.4	9.05
16	338.5	5.65	345.4	5.95	350.1	6.38	352.4	7.05	351.1	7.59
18	340.6	4.79	347.3	5.05	352.4	5.46	355.0	6.02	353.4	6.55
20	342.3	4.19	349.2	4.42	354.5	4.70	357.2	5.19	355.2	5.75
25	345.6	3.10	352.9	3.34	358.6	3.45	363.7	3.75	359.6	4.39
30	348.1	2.35	355.8	2.52	361.6	2.72	365.0	2.98	363.6	3.50
40	351.6	1.59	360.0	1.70	365.9	1.89	369.6	2.05	370.3	2.33
50	354.4	1.15	362.7	1.25	368.8	1.39	373.0	1.53	374.2	1.71
$\Delta I/_{\epsilon} P_a$	0.192		0.194		0.195		0.194		0.191	

UDMH Oxygen

Shifting Equilibrium

$P_c = 150$

P_e	r = 1.10		r = 1.20		r = 1.30		r = 1.40		r = 1.50	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	236.4	2.23	239.2	2.28	240.7	2.34	241.1	2.39	240.7	2.43
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	272.5	17.5	274.0	18.0	277.0	18.5	278.2	19.00	278.5	20.0
6	308.9	3.48	313.0	3.62	316.4	3.80	318.9	4.00	319.2	4.15
10	320.4	1.68	325.5	1.75	330.0	1.84	331.7	1.90	333.5	2.10
12	323.8	1.30	329.5	1.40	334.0	1.50	335.9	1.53	338.3	1.60
14	326.5	1.09	332.7	1.20	336.9	1.21	339.6	1.30	341.6	1.32
16	329.0	0.89	335.4	0.98	339.7	0.99	342.5	1.10	344.6	1.10
20	332.8	0.68	339.5	0.70	343.7	0.70	347.0	0.80	349.5	0.80
25	336.5	0.49	343.0	0.55	347.7	0.55	351.5	0.59	354.4	0.60
30	339.0	0.39	345.5	0.40	350.5	0.42	354.5	0.42	357.4	0.55
40	342.5	0.20	349.9	0.28	355.0	0.30	358.5	0.30	362.0	0.35
50	345.7	0.19	352.9	0.20	358.4	0.20	362.5	0.22	365.6	0.25
$\Delta I/_{\epsilon} P_a$	0.124		0.125		0.126		0.126		0.125	

UDMH-Oxygen

Shifting Equilibrium

$P_c = 300$

P_e	r = 1.20		r = 1.30		r = 1.40		r = 1.50		r = 1.60	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	265.7	3.58	268.3	3.68	269.8	3.79	270.2	3.91	269.6	4.00
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	277.5	32.5	279.0	34.0	279.0	37.5	279.0	37.5	279.0	38.3
6	313.9	7.0	317.8	7.30	320.4	7.35	320.4	8.19	320.5	8.3
10	325.6	3.45	330.2	3.59	334.4	3.88	335.5	4.0	335.8	4.10
12	330.2	2.70	334.4	2.83	337.5	2.87	339.6	3.17	340.4	3.40
14	333.4	2.19	337.5	2.39	341.0	2.40	343.0	2.60	343.7	2.78
16	335.6	1.84	340.2	2.00	343.6	2.10	345.8	2.20	346.6	2.30
20	339.5	1.38	344.4	1.49	347.9	1.50	350.0	1.60	351.8	1.70
25	343.0	1.00	348.4	1.10	352.4	1.12	354.4	1.20	356.9	1.30
30	345.6	0.78	351.0	0.80	355.4	0.84	358.5	0.90	360.5	1.10
40	350.0	0.45	35[illegible].4	0.52	359.8	0.60	363.0	0.60	365.5	0.70
50	352.6	0.40	358.5	0.40	363.3	0.45	366.6	0.45	369.0	0.50
$\Delta I/_{\epsilon} P_a$	0.629		0.632		0.63[illegible]		0.631		0.628	

UDMH-Oxygen

Shifting Equilibrium

$P_c = 500$

P_e	r = 1.30		r = 1.40		r = 1.50		r = 1.60		r = 1.70	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	285.0	5.22	287.2	5.39	288.3	5.58	288.4	5.77	287.6	5.93
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
4	305.0	20.60	307.5	21.20	308.0	21.80	307.0	23.20	305.5	23.60
7	321.6	9.79	324.0	10.60	326.0	10.80	325.9	11.58	325.0	12.00
10	330.6	5.94	333.5	6.25	335.9	6.59	336.3	6.95	336.0	7.40
12	334.8	4.78	338.0	4.82	340.5	5.25	341.0	5.50	341.0	5.80
14	338.0	3.98	341.4	3.98	343.6	4.30	344.8	4.50	344.6	4.75
16	340.8	3.40	343.9	3.40	345.5	3.59	347.7	3.70	346.2	3.97
20	345.0	2.50	348.3	2.50	351.0	2.60	352.8	2.78	353.0	3.00
25	349.0	1.82	352.5	1.82	355.6	1.82	357.5	2.00	358.5	2.30
30	351.8	1.40	355.8	1.40	358.9	1.40	360.9	1.60	362.0	1.82
40	355.8	0.90	360.3	0.98	363.6	0.98	365.9	1.00	368.0	1.20
50	359.7	0.60	363.5	0.80	366.9	0.80	369.5	0.98	371.0	1.00
$\Delta I / \epsilon P_a$	0.381		0.381		0.381		0.379		0.376	

UDMH-Oxygen

Shifting Equilibrium

$P_c = 700$

P_e	r = 1.40		r = 1.50		r = 1.60		r = 1.70		r = 1.80	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	297.2	6.82	298.8	7.07	299.4	7.33	299.0	7.59	297.7	7.79
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
6	321.0	17.40	322.0	19.50	322.7	20.20	321.3	20.40	320.0	20.70
8	329.0	11.44	330.4	12.10	331.4	12.70	330.4	13.50	329.4	14.10
10	334.5	8.45	336.2	8.90	337.5	9.48	336.9	9.98	336.2	10.48
12	338.5	6.68	340.4	7.10	342.0	7.48	341.8	7.82	341.0	8.28
14	341.7	5.45	343.9	5.72	345.6	6.10	345.7	6.49	344.8	6.79
16	344.5	4.59	346.9	4.78	348.7	5.05	349.0	5.50	348.3	5.72
20	349.0	3.42	351.6	3.58	353.5	3.73	354.2	4.18	353.5	4.38
25	353.2	2.58	356.0	2.63	358.0	2.84	358.9	3.10	358.6	3.30
30	356.0	1.89	359.0	2.05	361.2	2.25	362.4	2.52	362.6	2.67
40	360.5	1.25	363.7	1.30	366.0	1.49	367.6	1.60	368.0	1.79
50	363.6	1.00	367.4	1.00	369.9	1.02	371.6	1.21	372.4	1.25
$\Delta I/_{\epsilon} P_a$	0.273		0.273		0.272		0.270		0.268	

UDMH-Oxygen

Shifting Equilibrium

$P_c = 1000$

P_e	r = 1.40		r = 1.50		r = 1.60		r = 1.70		r = 1.80	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	306.8	8.78	308.9	9.10	310.0	9.47	310.0	9.84	309.1	10.19
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
6	322.0	26.0	323.7	26.30	324.3	26.60	322.3	28.50	321.8	29.00
8	329.0	16.45	331.4	17.20	332.3	18.20	331.4	19.20	330.3	19.90
10	334.3	12.10	336.9	12.44	337.9	13.50	337.8	14.19	336.8	15.05
12	338.3	9.45	341.0	10.0	342.4	10.63	342.6	11.20	341.7	11.85
14	341.6	7.69	344.5	8.19	346.2	8.64	346.5	9.09	345.7	9.63
16	344.4	6.53	347.5	6.85	349.3	7.23	349.7	7.59	349.0	8.19
20	349.0	4.90	352.4	5.10	354.0	5.37	354.6	5.68	354.5	6.24
25	353.4	3.70	356.5	3.84	358.5	4.10	359.5	4.30	359.5	4.52
30	356.5	2.90	359.6	3.10	362.0	3.18	363.0	3.39	363.4	3.52
40	361.0	1.99	364.4	2.20	367.0	2.19	368.4	2.30	368.9	2.43
50	364.0	1.42	367.5	1.50	370.4	1.62	372.0	1.66	373.0	1.89
$\Delta I / \epsilon P_a$	0.192		0.191		0.191		0.190		0.188	

Hydrazine-UDMH (50/50) - Liquid Oxygen

Shifting Equilibrium

P_c : 150

P_e	r = 0.800		r = 0.900		r = 1.00		r = 1.10		r = 1.20	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	237.2	2.21	240.7	2.27	242.6	2.33	243.1	2.39	242.3	2.44
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	274.8	16.25	278.0	17.20	278.2	18.00	279.6	18.20	279.2	18.65
6	309.4	3.45	315.2	3.60	318.9	3.68	321.4	3.90	321.0	4.15
10	320.8	1.65	327.4	1.69	332.2	1.80	335.4	1.95	336.2	2.08
12	324.5	1.29	331.0	1.30	336.2	1.41	339.2	1.52	341.0	1.65
14	327.0	1.01	3[illegible].8	1.02	339.6	1.19	342.6	1.28	344.6	1.34
16	329.4	0.81	336.4	0.85	342.2	0.99	345.6	1.10	347.6	1.11
20	333.0	0.60	340.6	0.69	346.2	0.70	350.2	0.80	352.2	0.81
25	336.5	0.41	344.2	0.55	350.0	0.58	354.4	0.60	356.7	0.65
30	339.4	0.40	346.7	0.40	352.8	0.41	357.6	0.4[illegible]	360.0	0.50
40	342.6	0.21	350.6	0.25	357.0	0.30	362.0	0.30	362.6	0.34
50	347.5	0.19	35[illegible].8	0.20	360.2	0.21	365.1	0.23	368.3	0.24
$\Delta I/_{\epsilon} P_a$	1.248		1.265		1.270		1.268		1.261	

Hydrazine-UDMH (50/50) - Liquid Oxygen

Shifting Equilibrium

P_c = 300

P_e	r = 0.90		r = 1.00		r = 1.10		r = 1.20		r = 1.30	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	267.1	3.55	270.3	3.66	271.9	3.79	272.0	3.92	270.9	4.03
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
3	295.0	17.20	297.6	18.85	298.6	18.90	297.0	19.30	296.0	19.90
6	315.6	7.00	319.6	7.45	321.8	7.70	322.8	8.10	322.0	8.70
10	327.6	3.32	332.6	3.52	335.8	3.79	337.0	4.00	337.2	4.30
12	331.4	2.65	336.2	2.79	339.9	3.01	342.0	3.18	342.2	3.35
14	334.2	2.28	339.4	2.25	343.0	2.48	345.5	2.58	346.3	2.75
16	336.8	1.80	342.0	1.89	346.0	2.05	348.4	2.18	349.6	2.30
20	340.8	1.35	346.5	1.40	350.3	1.50	353.2	1.60	354.6	1.75
25	344.4	1.00	350.5	1.08	354.8	1.12	355.5	1.20	359.0	1.30
30	347.2	0.80	353.2	0.81	357.8	0.90	360.7	0.92	362.4	1.00
40	350.2	0.50	357.6	0.58	362.3	0.60	365.6	0.61	367.8	0.70
50	354.0	0.39	360.6	0.42	365.6	0.45	369.3	0.48	372.0	0.51
$\Delta I / \epsilon P_a$	0.634		0.638		0.638		0.635		0.630	

Hydrazine-UDMH (50/50) - Liquid Oxygen

Shifting Equilibrium

$P_c = 500$

P_e	r = 0.90		r = 1.00		r = 1.10		r = 1.20		r = 1.30	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	283.0	5.03	286.9	5.19	289.3	5.38	290.3	5.60	289.9	5.83
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
5	311.0	14.50	314.6	15.10	317.0	19.30	318.2	17.60	317.2	17.60
7	319.8	9.00	324.3	9.50	327.1	10.20	328.6	10.80	328.3	11.20
10	327.8	5.60	333.1	5.85	336.3	6.25	338.2	6.62	338.6	7.10
12	331.4	4.35	336.8	4.58	340.3	4.85	343.0	5.15	343.5	5.60
14	334.3	3.59	339.8	3.78	343.6	4.00	346.1	4.21	347.0	4.55
16	337.0	3.00	342.4	3.15	346.4	3.35	349.0	3.51	350.0	3.80
20	341.1	2.19	346.1	2.32	351.2	2.45	353.9	2.58	355.0	2.81
25	344.7	1.62	350.7	1.78	355.2	1.82	358.4	1.92	359.6	2.12
30	347.2	1.25	353.7	1.39	358.3	1.41	361.7	1.51	363.2	1.70
40	351.1	0.88	357.8	0.90	362.7	0.99	366.2	1.01	368.4	1.11
50	354.1	0.65	360.8	0.69	366.0	0.73	371.8	0.79	372.3	0.84
$\Delta I/_{\epsilon}P_a$	0.381		0.384		0.384		0.383		0.380	

Hydrazine-UDMH (50/50) - Liquid Oxygen

Shifting Equilibrium

$P_C = 700$

P_e	r = 1.00		r = 1.10		r = 1.20		r = 1.30		r = 1.40	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	296.5	6.56	299.5	6.81	301.1	7.10	301.1	7.42	299.8	7.70
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
5	314.8	21.00	317.1	22.10	318.8	23.20	317.8	25.10	316.6	25.70
7	324.5	13.49	327.5	14.10	329.0	14.80	328.6	16.00	327.6	16.55
10	333.2	8.15	337.0	8.65	339.0	9.20	339.4	9.85	338.0	10.40
12	337.0	6.45	341.4	6.79	343.3	7.15	344.2	7.71	343.4	8.15
14	339.7	5.25	344.1	5.55	346.4	5.95	347.8	6.39	347.4	6.78
16	342.6	4.38	347.0	4.65	349.8	4.95	350.7	5.45	350.3	5.71
20	347.2	3.18	351.6	3.41	354.1	3.61	355.8	3.95	355.5	4.19
25	351.5	2.35	355.6	2.52	358.8	2.68	360.4	2.83	360.4	3.11
30	354.4	1.88	358.7	2.01	362.0	2.11	363.6	2.27	364.0	2.50
40	358.2	1.30	363.1	1.41	366.4	1.48	368.8	1.61	369.8	1.72
50	360.9	0.96	366.2	1.03	370.1	1.10	372.7	1.17	373.7	1.31
$\Delta I/_{\epsilon} P_a$	0.275		0.275		0.274		0.272		0.270	

Hydrazine-UDMH (50/50) - Liquid Oxygen

Shifting Equilibrium

$P_c = 1000$

P_e	r = 1.00		r = 1.10		r = 1.20		r = 1.30		r = 1.40	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	305.7	8.45	309.1	8.76	311.2	9.14	311.9	9.58	311.1	10.04
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
7	325.4	18.80	328.2	20.20	329.8	21.30	329.8	22.25	328.6	23.75
10	333.5	11.50	337.2	12.30	339.8	12.90	339.8	13.80	339.0	14.70
12	337.5	9.10	341.3	9.48	343.9	10.05	344.6	10.70	344.0	11.58
14	340.9	7.35	344.9	7.68	347.1	8.15	348.6	8.71	348.2	9.48
16	343.4	6.18	347.6	6.51	349.8	6.91	351.6	7.32	351.5	7.90
18	345.5	5.25	349.8	5.54	352.4	5.99	354.4	6.35	354.3	6.80
20	347.4	4.48	351.8	4.80	354.8	5.18	356.6	5.58	356.5	5.98
25	351.0	3.25	355.9	3.51	359.4	3.70	361.1	4.04	361.2	4.40
30	353.9	2.61	359.0	2.80	362.6	2.97	364.5	3.20	364.8	3.50
40	359.8	1.80	363.2	1.95	366.8	2.05	369.2	2.21	371.9	2.48
50	361.0	1.37	366.4	1.46	370.4	1.56	373.2	1.66	374.6	1.76
$\Delta I/_{\epsilon} P_a$	0.192		0.193		0.193		0.191		0.190	

Liquid Ammonia - Liquid Oxygen

Shifting Equilibrium

P_c = 150

P_e	r = 1.10		r = 1.20		r = 1.30		r = 1.40		r = 1.50	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	227.4	2.25	230.5	2.30	231.8	2.37	230.7	2.42	228.0	2.41
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	260.0	17.20	264.8	17.80•	265.6	17.90	263.6	18.80	262.0	20.70
6	297.4	3.55	302.9	3.65	305.6	3.90	305.6	4.15	301.4	4.11
10	309.0	1.68	314.7	1.82	318.8	1.95	319.6	2.08	315.5	2.01
12	312.2	1.29	318.2	1.42	322.6	1.49	323.9	1.59	319.6	1.58
14	314.9	1.02	321.2	1.17	325.6	1.21	327.2	1.27	322.9	1.30
16	317.2	0.88	323.6	0.97	328.2	1.00	330.0	1.03	325.6	1.10
20	320.9	0.60	327.7	0.70	332.5	0.71	334.8	0.80	330.2	0.87
25	324.2	0.40	331.2	0.50	336.4	0.50	339.2	0.60	334.4	0.68
30	327.0	0.38	333.9	0.39	339.2	0.43	342.3	0.48	337.6	0.51
40	330.4	0.20	337.6	0.30	343.4	0.30	346.6	0.30	341.6	0.40
50	333.1	0.19	340.6	0.20	346.4	0.22	350.1	0.24	345.0	0.24
$\Delta I/_{\epsilon} P_a$	1.195		1.208		1.210		1.202		1.188	

Liquid Ammonia - Liquid Oxygen
Shifting Equilibrium
$P_c = 300$

P_e	$r = 1.10$		$r = 1.20$		$r = 1.30$		$r = 1.40$		$r = 1.50$	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	251.9	3.54	256.1	3.62	258.6	3.75	258.5	3.90	255.2	3.87
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
3	277.8	17.50	282.0	17.85	284.0	18.25	283.6	19.50	280.0	19.30
6	297.7	6.95	302.0	7.03	306.4	7.60	307.0	8.30	302.6	8.15
10	309.6	3.35	315.2	3.50	319.1	3.70	320.7	4.04	316.2	3.95
12	312.6	2.62	318.7	2.79	323.1	2.90	324.9	3.20	320.4	3.08
14	315.4	2.12	321.6	2.29	326.0	2.39	328.1	2.58	323.7	2.52
16	317.6	1.78	323.9	1.85	328.7	2.00	330.8	2.15	326.3	2.11
20	321.2	1.29	327.9	1.40	333.1	1.50	335.2	1.59	330.7	1.55
25	324.4	0.95	331.6	1.05	336.7	1.12	339.8	1.20	334.9	1.18
30	327.1	0.75	334.3	0.80	339.6	0.90	343.0	0.92	337.9	0.91
40	330.9	0.50	338.0	0.52	343.6	0.60	347.2	0.61	342.2	0.61
50	333.2	0.36	340.8	0.39	346.7	0.43	350.6	0.47	345.4	0.46
$\Delta I/_{\epsilon} P_a$	0.598		0.606		0.608		0.604		0.597	

Liquid Ammonia - Liquid Oxygen

Shifting Equilibrium

$P_c = 500$

P_e	r = 1.10		r = 1.20		r = 1.30		r = 1.40		r = 1.50	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	266.7	5.03	271.5	5.15	274.8	5.33	275.6	5.60	271.9	5.54
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
5	292.8	14.60	298.2	15.20	301.4	16.00	301.8	17.10	298.4	16.60
7	301.6	9.10	307.0	9.59	310.8	10.05	311.8	10.75	308.0	10.48
10	309.3	5.49	315.4	5.84	319.6	6.08	321.0	6.65	317.0	6.65
12	313.7	4.19	319.2	4.62	323.4	4.78	325.4	5.20	321.0	5.12
14	315.5	3.39	322.0	3.78	326.4	3.95	328.6	4.31	324.0	4.25
16	317.8	2.84	324.3	3.13	329.0	3.29	331.4	3.60	326.7	3.52
20	321.3	2.11	328.2	2.25	333.2	2.42	336.0	2.65	331.3	2.59
25	324.7	1.59	331.7	1.70	337.1	1.89	340.4	1.95	335.3	1.98
30	327.2	1.20	334.4	1.31	339.9	1.45	343.5	1.51	338.3	1.52
40	330.3	0.80	338.2	0.90	344.0	0.91	347.7	1.01	342.4	1.02
50	333.2	0.60	340.9	0.65	346.9	0.71	350.9	0.78	345.7	0.76
$\Delta I / \epsilon P_a$	0.359		0.364		0.366		0.364		0.359	

Liquid Ammonia - Liquid Oxygen
Shifting Equilibrium
P_c = 700

P_e	r = 1.10		r = 1.20		r = 1.30		r = 1.40		r = 1.50	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	275.3	6.37	280.5	6.53	284.2	6.75	285.6	7.12	281.6	7.04
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
5	293.0	20.05	297.8	20.75	301.6	22.10	302.2	23.95	298.4	23.40
7	301.8	12.65	307.0	13.30	311.2	13.90	312.5	14.90	308.3	14.75
10	309.4	7.75	315.5	8.15	319.6	8.50	321.8	9.18	317.2	8.98
12	312.8	6.05	318.8	6.32	323.5	6.66	325.8	7.25	321.2	7.09
14	315.6	4.85	321.6	5.12	326.3	5.38	329.0	5.82	324.4	5.74
16	317.8	4.05	324.2	4.28	329.0	4.49	331.8	4.85	327.0	4.78
20	321.2	3.04	328.2	3.13	333.4	3.36	336.3	3.65	331.6	3.61
25	324.6	2.23	331.7	2.30	337.2	2.39	340.4	2.69	335.6	2.62
30	327.1	1.70	334.4	1.75	340.1	2.00	343.4	2.11	338.6	2.09
40	330.8	1.17	338.2	1.25	344.2	1.34	347.8	1.48	342.8	1.42
50	333.2	0.85	340.9	0.91	347.0	0.99	351.2	1.09	345.9	1.07
$\Delta I / \epsilon P_a$	0.257		0.260		0.262		0.260		0.257	

Liquid Ammonia - Liquid Oxygen

Shifting Equilibrium

P_c = 1000

P_e	r = 1.10		r = 1.20		r = 1.30		r = 1.40		r = 1.50	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	283.4	8.19	289.0	8.42	293.2	8.71	295.2	9.19	290.1	9.09
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
7	302.6	18.35	307.4	19.20	311.6	20.05	312.6	21.20	308.6	21.00
10	309.5	11.05	315.5	11.48	320.2	12.10	321.8	13.15	317.5	12.85
12	313.0	8.55	319.0	8.95	324.0	9.48	326.0	10.25	321.6	10.15
14	315.8	6.91	321.7	7.25	327.0	7.68	329.3	8.29	324.6	8.15
16	318.0	5.82	324.2	6.05	329.6	6.43	332.0	6.95	327.1	6.84
18	319.9	4.95	326.5	5.18	331.6	5.52	334.4	6.00	329.4	5.89
20	321.6	4.20	328.2	4.47	333.4	4.61	336.6	5.20	331.6	5.08
25	324.8	3.08	331.8	3.30	337.2	3.43	340.8	3.75	335.6	3.72
30	327.2	2.45	334.4	2.60	340.1	2.75	343.8	2.98	338.7	2.95
40	330.6	1.66	338.3	1.74	344.1	1.90	348.1	2.10	342.9	2.05
50	333.2	1.21	341.0	1.37	347.1	1.41	351.4	1.54	346.1	1.52
$\Delta I/_{\epsilon} P_a$	0.180		0.182		0.183		0.183		0.180	

Hydrazine - Nitrogen Tetroxide

Shifting Equilibrium

$P_c = 150$

P_e	r = 0.80		r = 0.90		r = 1.00		r = 1.10		r = 1.20	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	226.6	2.19	228.6	2.22	229.9	2.25	230.5	2.29	230.4	2.34
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	261.0	16.80	262.8	17.20	264.8	17.50	265.6	17.60	264.8	18.20
6	295.2	3.28	298.4	3.30	300.6	3.55	301.8	3.60	303.1	3.75
10	305.6	1.56	309.2	1.60	312.2	1.65	314.2	1.76	315.8	1.76
12	308.6	1.22	312.3	1.29	315.5	1.31	317.9	1.40	319.3	1.41
14	311.0	0.99	315.0	1.02	318.1	1.08	320.8	1.15	322.2	1.18
16	313.2	0.80	317.3	0.85	320.3	0.90	323.0	0.95	324.6	0.98
20	316.5	0.58	321.0	0.60	324.1	0.64	326.8	0.69	328.4	0.71
25	319.6	0.40	324.0	0.42	327.4	0.47	330.4	0.49	332.2	0.50
30	321.6	0.30	326.4	0.31	330.0	0.32	333.0	0.36	334.9	0.40
40	324.8	0.20	329.6	0.21	333.6	0.21	336.7	0.30	338.8	0.30
50	327.0	0.16	332.0	0.17	336.0	0.18	339.3	0.19	341.8	0.20
$\Delta I/_{\epsilon} P_a$	1.193		1.203		1.208		1.209		1.205	

Hydrazine - Nitrogen Tetroxide

Shifting Equilibrium

$P_c = 300$

P_e	r = 0.90		r = 1.00		r = 1.10		r = 1.20		r = 1.30	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	252.9	3.46	254.8	3.52	256.1	3.59	256.7	3.68	256.5	3.78
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
3	278.4	16.50	281.2	17.15	282.6	18.20	282.2	18.30	282.0	18.50
6	298.3	6.65	301.0	6.88	302.0	7.05	303.8	7.45	304.2	7.65
10	309.5	3.15	312.6	3.25	314.8	3.38	316.2	3.55	316.7	3.69
12	312.8	2.50	315.8	2.58	318.2	2.65	319.8	2.80	320.4	2.95
14	315.4	2.00	318.4	2.08	320.8	2.15	322.6	2.30	323.4	2.40
16	317.4	1.68	320.9	1.75	323.0	1.80	325.2	1.92	325.9	2.00
20	320.8	1.22	324.5	1.29	326.8	1.30	329.3	1.40	330.3	1.49
25	323.8	0.90	327.8	0.95	330.2	0.98	332.8	1.01	334.2	1.09
30	326.4	0.69	330.2	0.70	332.6	0.80	335.4	0.80	337.0	0.80
40	329.6	0.41	333.6	0.50	336.6	0.50	339.2	0.53	341.0	0.60
50	332.0	0.33	336.2	0.35	339.5	0.37	342.1	0.39	344.0	0.42
$\Delta I / \epsilon P_a$	0.603		0.606		0.607		0.605		0.602	

Hydrazine - Nitrogen Tetroxide

Shifting Equilibrium

$P_c = 500$

P_e	r = 1.00		r = 1.10		r = 1.20		r = 1.30		r = 1.40	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	269.8	4.98	271.5	5.08	272.6	5.20	272.9	5.35	272.1	5.55
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
5	296.2	14.00	298.2	14.60	298.7	15.20	299.5	15.60	296.0	16.10
7	304.8	8.94	306.8	9.30	308.1	9.55	308.6	9.80	307.8	10.05
10	312.2	5.48	315.1	5.67	316.7	5.85	317.2	6.14	317.0	6.48
12	316.0	4.32	318.7	4.48	320.4	4.57	321.0	4.79	321.0	5.05
14	318.8	3.50	321.6	3.65	323.4	3.75	323.9	3.95	324.2	4.15
16	321.1	2.90	323.8	3.00	325.6	3.10	326.5	3.30	326.6	3.45
20	324.4	2.10	327.3	2.17	329.4	2.22	330.7	2.40	330.7	3.03
25	327.6	1.55	330.6	1.59	333.0	1.80	334.6	1.80	334.8	1.93
30	330.2	1.18	333.2	1.22	335.6	1.25	337.3	1.40	337.8	1.50
40	333.6	0.73	337.0	0.81	339.5	0.84	341.3	0.91	342.1	1.00
50	336.2	0.59	339.6	0.61	342.3	0.65	344.2	0.69	345.3	0.75
$\Delta I/_{\epsilon} P_a$	0.364		0.365		0.364		0.362		0.359	

Hydrazine-Nitrogen Tetroxide

Shifting Equilibrium

$P_c = 700$

P_e	r = 1.00		r = 1.10		r = 1.20		r = 1.30		r = 1.40	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	278.4	6.28	280.0	6.41	281.7	6.57	282.4	6.76	281.9	7.02
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
4	290.3	27.53	292.3	27.80	292.7	29.30	293.0	30.50	291.9	31.30
7	305.3	12.53	306.9	12.80	308.7	13.30	309.0	14.20	308.3	14.75
10	312.5	7.53	315.0	7.88	317.2	8.10	318.0	8.43	317.5	8.97
12	316.4	5.84	318.7	6.03	320.5	6.32	321.7	6.72	321.4	6.92
14	319.0	4.77	321.4	4.93	323.5	5.09	324.6	5.49	324.6	5.60
16	321.3	3.98	323.8	4.12	326.1	4.28	327.0	4.63	327.4	4.68
20	324.8	2.98	327.6	3.00	330.0	3.19	331.0	3.33	331.6	3.52
25	328.0	2.19	331.2	2.19	333.4	2.40	334.7	2.49	335.4	2.65
30	330.4	1.60	333.6	1.69	335.9	1.83	337.5	1.98	338.6	2.10
40	333.7	1.03	337.0	1.10	339.6	1.11	341.9	1.22	342.6	1.30
50	336.4	0.81	339.9	0.82	342.7	0.90	344.5	0.92	345.7	0.91
$\Delta I / \epsilon P_a$	0.260		0.260		0.261		0.260		0.257	

Hydrazine - Nitrogen Tetroxide

Shifting Equilibrium

$P_c = 1000$

P_e	r = 1.10		r = 1.20		r = 1.30		r = 1.40		r = 1.50	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	288.9	8.24	290.4	8.44	291.4	8.68	291.3	9.03	288.0	9.06
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
8	310.2	15.30	311.6	15.85	313.0	16.39	312.6	17.15	308.7	17.20
10	315.4	11.20	316.8	11.58	317.8	12.10	317.8	12.65	314.2	12.70
12	318.9	8.65	320.4	9.05	321.4	9.42	321.4	9.95	318.2	10.00
14	321.7	6.92	323.4	7.25	324.4	7.59	324.5	8.05	321.2	8.05
16	323.9	5.75	325.8	6.05	327.0	6.35	327.2	6.75	323.8	6.75
18	325.8	4.92	328.0	5.18	329.4	5.45	329.6	5.80	326.2	5.85
20	327.5	4.30	330.0	4.42	331.4	4.69	331.6	4.98	328.2	5.02
25	330.8	2.91	333.3	3.28	335.0	3.52	335.6	3.59	331.9	3.62
30	333.3	2.45	335.9	2.59	337.7	2.75	338.6	2.89	335.0	2.89
40	336.9	1.69	339.8	1.75	341.6	1.90	342.8	2.00	339.1	2.00
50	339.8	1.23	342.5	1.29	344.6	1.38	345.8	1.48	342.2	1.49
$\Delta I/_{\epsilon} P_a$	0.183		0.183		0.182		0.181		0.179	

UDMH-Nitrogen Tetroxide

Shifting Equilibrium

$P_c = 150$

P_e	r = 1.90		r = 2.00		r = 2.10		r = 2.20		r = 2.30	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	222.1	2.26	222.9	2.29	223.4	2.32	223.5	2.36	223.3	2.39
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	256.5	17.80	257.5	17.90	257.5	17.90	258.5	17.90	258.5	18.60
4	279.5	6.23	281.0	6.23	281.8	6.32	282.7	6.39	283.0	6.70
7	294.3	2.80	296.0	2.93	297.3	2.98	298.0	3.00	299.0	3.18
10	301.5	1.65	303.7	1.79	305.4	1.83	306.7	1.91	307.8	1.98
12	305.2	1.39	307.5	1.39	309.3	1.42	310.7	1.44	311.9	1.44
16	310.5	0.86	312.9	0.86	314.7	0.98	316.3	0.98	317.5	1.03
20	314.4	0.60	316.8	0.64	318.4	0.72	319.9	0.72	321.2	0.73
25	317.9	0.40	320.3	0.45	322.0	0.59	323.6	0.50	324.9	0.50
30	320.3	0.39	322.6	0.40	324.8	0.40	326.4	0.40	327.6	0.40
40	324.0	0.20	326.5	0.25	329.0	0.25	330.6	0.25	332.0	0.25
50	326.4	0.12	329.4	0.20	331.6	0.20	333.6	0.20	335.2	0.22
$\Delta I / \epsilon P_a$	1.166		1.169		1.169		1.168		1.165	

UDMH-Nitrogen Tetroxide

Shifting Equilibrium

$P_c = 300$

P_e	r = 2.00		r = 2.10		r = 2.20		r = 2.30		r = 2.40	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	247.7	3.60	248.7	3.66	249.3	3.72	249.6	3.79	249.6	3.86
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
3	272.2	19.40	272.5	21.10	273.0	21.50	273.0	22.30	272.8	22.30
5	288.3	8.33	288.9	9.10	290.3	9.48	291.3	9.58	290.4	9.98
7	296.9	5.43	298.3	5.83	298.9	6.05	300.2	6.17	300.2	6.33
10	304.4	3.44	306.2	3.53	307.4	3.58	308.3	3.78	308.9	3.89
12	308.0	2.75	309.8	2.79	311.3	2.83	312.2	2.98	312.8	3.05
16	313.2	1.83	315.2	1.83	316.6	1.93	317.8	2.01	318.6	2.11
20	316.9	1.32	319.2	1.40	320.5	1.42	321.6	1.49	323.0	1.54
25	320.5	0.85	322.7	1.01	324.2	1.01	325.7	1.05	327.0	1.15
30	322.9	0.79	325.2	0.79	326.9	0.80	328.6	0.80	330.0	0.90
40	327.1	0.44	329.0	0.57	331.0	0.58	332.6	0.60	334.0	0.60
50	329.9	0.40	331.3	0.40	334.2	0.40	335.9	0.44	337.0	0.49
$\Delta I/_{\epsilon}P_a$	0.587		0.587		0.587		0.586		0.584	

UDMH-Nitrogen Tetroxide

Shifting Equilibrium

$P_c = 500$

P_e	r = 2.20		r = 2.30		r = 2.40		r = 2.50		r = 2.60	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	265.0	5.27	265.7	5.37	266.0	5.48	266.1	5.60	265.7	5.72
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
4	283.7	21.90	284.4	21.70	284.4	21.50	284.0	21.50	283.5	21.60
7	299.8	9.75	300.2	10.03	300.4	10.29	301.3	10.73	301.0	11.05
10	307.9	5.98	308.7	6.02	309.7	6.42	309.8	6.63	309.7	6.83
12	311.7	4.62	312.4	4.84	314.0	5.08	314.2	5.22	314.1	5.38
14	314.6	3.73	315.4	3.99	317.2	4.19	317.3	4.28	317.5	4.42
16	316.9	3.18	318.0	3.33	319.7	3.48	319.9	3.53	320.3	3.64
20	320.8	2.38	322.4	2.44	323.8	2.52	324.0	2.60	324.6	2.69
25	324.7	1.79	326.3	1.82	327.5	1.89	328.0	1.93	328.6	2.00
30	327.5	1.40	329.1	1.42	330.5	1.50	331.0	1.59	331.6	1.59
40	331.6	0.90	333.1	0.99	334.6	1.00	335.5	1.00	336.1	1.10
50	334.4	0.70	336.2	0.70	337.5	0.75	338.8	0.75	339.5	0.80
$\Delta I/_{\epsilon} P_a$	0.353		0.353		0.352		0.351		0.349	

UDMH-Nitrogen Tetroxide

Shifting Equilibrium

$P_c = 700$

P_e	r = 2.20		r = 2.30		r = 2.40		r = 2.50		r = 2.60	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	274.0	6.67	274.9	6.80	275.5	6.94	275.8	7.09	275.7	7.26
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
4	284.3	29.50	284.5	30.80	284.7	31.0	284.7	31.75	284.3	32.75
7	300.3	13.70	300.9	14.0	301.5	14.30	301.8	14.79	301.7	15.30
10	308.3	8.33	309.2	8.53	310.0	8.93	310.7	9.13	310.4	9.38
12	311.8	6.53	313.0	6.73	314.2	6.90	314.6	7.08	314.9	7.33
14	314.7	5.40	315.8	5.54	317.2	5.68	317.9	5.87	318.7	6.13
16	317.3	4.52	318.4	4.64	319.6	4.73	320.6	4.97	320.8	5.20
20	321.2	3.24	322.3	3.33	323.6	3.51	324.9	3.63	325.2	3.82
25	325.0	2.40	326.0	2.44	327.5	2.59	328.8	2.64	329.3	2.73
30	327.8	1.91	329.0	1.93	330.3	2.09	331.5	2.23	332.4	2.39
40	331.5	1.32	333.0	1.33	334.5	1.40	335.9	1.43	336.6	1.49
50	334.6	0.99	336.1	1.00	337.7	1.02	339.1	1.09	340.0	1.10
$\Delta I/_{\epsilon} P_a$	0.253		0.253		0.252		0.251		0.250	

UDMH-Nitrogen Tetroxide

Shifting Equilibrium

$P_c = 1000$

P_e	r = 2.30		r = 2.40		r = 2.50		r = 2.60		r = 2.70	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	283.8	8.76	284.6	8.94	285.1	9.14	285.3	9.35	285.1	9.59
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
6	297.0	24.9	297.7	26.5	297.7	27.50	297.6	27.60	296.9	28.50
8	304.0	16.30	304.7	16.90	305.5	17.50	305.3	17.90	304.8	18.80
10	309.6	12.10	310.3	12.43	311.0	13.00	310.9	13.30	310.7	13.85
12	313.4	9.43	314.4	9.78	315.5	10.25	315.0	10.43	315.4	10.83
14	316.4	7.73	317.4	7.93	318.6	8.40	318.3	8.58	318.5	8.75
16	318.7	6.43	318.9	6.61	321.4	7.00	320.9	7.13	321.3	7.32
20	322.6	4.78	324.0	4.93	325.4	5.13	325.5	5.28	325.7	5.49
25	326.3	3.61	328.0	3.72	329.3	3.72	330.0	4.02	330.0	4.10
30	329.1	2.83	331.0	2.91	332.0	2.98	333.1	3.19	333.1	3.21
40	334.0	1.90	335.0	2.00	336.5	2.02	337.2	2.09	337.7	2.19
50	336.6	1.44	338.0	1.49	339.5	1.50	340.0	1.58	341.2	1.60
$\Delta I / \epsilon P_a$	0.177		0.177		0.176		0.176		0.175	

UDMH-Hydrazine (50/50)-N_2O_4

Shifting Equilibrium

P_c = 150

P_e	r = 1.4		r = 1.5		r = 1.6		r = 1.7		r = 1.8	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	224.8	2.25	225.8	2.28	226.3	2.31	226.4	2.35	226.0	2.39
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
3	275.4	8.90	276.4	9.00	276.7	9.20	277.3	9.40	276.3	10.00
4	283.7	6.26	285.2	6.36	285.9	6.39	286.5	6.67	286.0	6.85
6	294.0	3.57	295.7	3.60	297.5	3.77	297.9	3.83	298.0	3.89
8	300.5	2.25	302.7	2.32	304.5	2.42	305.4	2.52	305.6	2.59
10	305.3	1.66	307.4	1.72	309.3	1.76	310.8	1.81	311.1	1.86
15	310.5	0.97	315.3	1.03	317.2	1.05	318.8	1.10	319.8	1.12
20	317.1	0.65	320.2	0.70	322.2	0.71	323.9	0.72	325.1	0.74
25	320.5	0.49	323.5	0.51	325.7	0.51	327.7	0.55	329.0	0.55
30	323.0	0.37	326.1	0.39	328.4	0.40	330.5	0.42	331.9	0.42
40	326.7	0.26	329.7	0.27	332.2	0.28	334.3	0.29	335.9	0.31
50	329.3	0.20	332.5	0.20	335.1	0.21	337.3	0.22	338.7	0.23
$\Delta I/_{\epsilon} P_a$	1.182		1.186		1.186		1.184		1.180	

UDMH-Hydrazine (50/50)-N_2O_4

Shifting Equilibrium

P_c = 300

P_e	r = 1.5		r = 1.6		r = 1.7		r = 1.8		r = 1.9	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	250.7	3.57	251.8	3.63	252.5	3.71	252.7	3.79	252.4	3.87
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
4	285.0	12.80	286.9	13.10	288.3	13.40	288.0	14.00	287.2	14.50
5	291.1	9.15	293.3	9.20	294.5	9.25	294.4	9.75	294.3	10.10
6	296.0	7.02	298.5	7.10	299.1	7.17	299.5	7.50	299.5	7.86
8	302.7	4.66	305.4	4.79	306.3	4.99	307.0	5.10	307.0	5.39
10	307.8	3.35	309.8	3.46	311.3	3.58	312.2	3.72	312.5	3.95
15	315.4	1.96	317.6	2.00	319.2	2.04	320.4	2.20	321.1	2.30
20	320.1	1.31	322.7	1.39	324.5	1.41	325.8	1.46	326.6	1.54
25	323.6	0.98	326.3	1.02	328.0	1.05	329.6	1.10	330.7	1.11
30	326.2	0.78	328.9	0.80	330.8	0.81	332.5	0.86	333.6	0.87
40	329.9	0.54	332.5	0.56	334.7	0.58	336.4	0.61	337.7	0.63
50	332.7	0.39	335.4	0.41	337.6	0.42	339.5	0.46	340.9	0.46
$\Delta I/_{\epsilon} P_a$	0.595		0.596		0.595		0.593		0.590	

UDMH-Hydrazine (50/50)-Nitrogen Tetroxide

Shifting Equilibrium

$P_c = 500$

P_e	r = 1.40		r = 1.60		r = 1.80		r = 1.90		r = 2.00	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	263.7	4.98	267.1	5.15	268.8	5.37	269.0	5.50	268.6	5.65
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
4	283.6	20.20	287.6	20.45	288.0	21.80	288.3	22.60	286.7	23.20
6	294.4	11.17	298.3	11.59	299.8	12.49	300.3	12.95	299.0	13.80
10	305.5	5.43	310.0	5.78	312.6	6.15	313.3	6.39	312.7	6.70
12	308.9	4.33	313.6	4.53	316.5	4.82	317.3	4.99	317.4	5.20
14	311.6	3.55	316.4	3.72	319.6	3.99	320.1	4.05	320.6	4.25
16	313.8	2.95	318.8	3.09	322.0	3.31	322.7	3.42	323.3	3.55
20	317.6	2.19	322.8	2.29	326.2	2.45	327.1	2.52	327.6	2.68
25	320.7	1.59	326.5	1.69	330.0	1.89	331.0	1.92	331.9	2.10
30	323.1	1.30	329.0	1.30	332.9	1.44	334.0	1.50	335.0	1.60
40	326.9	0.81	333.0	0.82	336.6	0.93	338.1	1.00	339.1	1.10
50	329.6	0.63	335.6	0.68	339.8	0.73	341.3	0.76	342.4	0.79
$\Delta I/_{\epsilon} P_a$	0.356		0.358		0.357		0.356		0.354	

UDMH-Hydrazine (50/50)-Nitrogen Tetroxide

Shifting Equilibrium

P_c = 700

P_e	r = 1.50		r = 1.60		r = 1.80		r = 1.90		r = 2.00	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	274.3	6.40	276.0	6.51	278.2	6.79	278.6	6.96	278.6	7.16
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
5	291.6	20.30	293.6	20.70	296.0	22.45	295.2	23.25	294.6	23.85
7	299.0	12.95	302.4	13.10	304.4	14.00	305.0	14.25	304.6	15.00
10	308.0	7.78	310.2	8.50	313.0	8.60	313.8	8.85	313.6	9.20
12	311.6	6.09	313.8	6.24	317.0	6.72	317.6	6.85	317.8	7.24
14	314.4	4.95	316.4	5.08	319.8	5.51	320.7	5.65	320.8	6.00
16	316.8	4.10	319.0	4.25	322.2	4.63	323.2	4.82	323.4	5.00
20	320.4	3.40	322.8	3.15	326.4	3.39	327.8	3.55	328.0	3.70
25	323.9	2.30	326.4	2.33	330.2	2.52	331.4	2.62	332.2	2.69
30	326.4	1.80	328.1	1.85	333.0	2.01	334.4	2.09	335.0	2.10
40	330.0	1.25	332.8	1.30	337.0	1.39	338.4	1.49	339.4	1.40
50	332.9	0.91	335.6	0.94	340.0	1.02	341.7	1.04	342.7	1.10
$\Delta I/_{\epsilon} P_a$	0.255		0.256		0.256		0.255		0.253	

UDMH-Hydrazine (50/50)-Nitrogen Tetroxide

Shifting Equilibrium

$\frac{P_c}{} = 1000$

P_e	r = 1.40		r = 1.60		r = 1.80		r = 2.00		r = 2.10	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	280.2	8.11	284.5	8.39	287.1	8.74	288.0	9.21	287.7	9.51

ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
7	298.2	18.10	301.2	18.90	304.8	19.70	305.2	21.10	303.8	22.20
10	305.6	10.90	310.2	11.40	313.4	12.10	314.2	13.15	313.8	13.59
12	309.4	8.40	313.8	8.95	317.0	9.45	318.2	10.19	318.0	10.65
14	311.8	6.79	316.6	7.25	319.9	7.65	321.2	8.25	321.1	8.68
16	314.0	5.70	319.0	6.10	322.4	6.45	323.8	6.95	323.8	7.25
18	316.0	4.90	321.4	5.20	324.6	5.55	326.2	5.99	326.2	5.25
20	317.6	4.29	323.0	4.48	326.6	4.75	328.4	5.15	328.4	5.45
25	320.9	3.22	326.6	3.35	330.2	3.49	332.4	3.78	332.8	3.95
30	323.2	2.49	329.4	2.68	333.2	2.80	335.6	3.00	336.0	3.15
40	327.0	1.70	332.9	1.80	337.2	1.92	339.8	2.09	340.4	2.19
50	329.7	1.27	335.7	1.35	340.1	1.45	343.0	1.56	343.7	1.63
$\Delta I / \epsilon P_a$	0.178		0.179		0.179		0.178		0.177	

GAS COMPOSITION - OXYGEN AND N_2O_4 SYSTEMS

CALCULATION OF SPECTRAL EMISSIVITIES OF GASES

For the purpose of designing detection systems capable of identifying and tracking missiles during the launch phase by means of infrared radiation, it is essential to be able to make reasonable estimates of the energy radiated by the missile exhaust in the sensitive wavelength region of the detector. One of the most important factors in a theoretical calculation of this quantity is the spectral emissivity of the chemical components present in the exhaust. Experimental determination of the spectral emissivity is quite difficult because of the elevated temperatures of the gases comprising the exhaust, slit width corrections, and the problem of making absolute intensity measurements. Theoretical calculations of the type performed by Stull and Plass (Ref. 1) for diatomic molecules are extremely complex and require extensive machine calculations for a complete treatment. In addition, these quantum mechanical calculations require a knowledge of the shapes of individual rotational lines, parameters which can be determined only by experiments of the same type used to measure spectral emissivities (Ref. 2).

A method of calculation proposed by Golden is based on a calculation by Penner, Sulzmann, and Ludwig and gives good estimates of radiation more simply than by the Plass method.

Golden has treated only the HF and HCl molecules in his paper, which leaves the task of applying a suitable and simple approximate calculation to other molecules that are present in the combustion equilibrium of typical propellants. This is particularly important for H_2O and CO_2 which are formed from many propellant combinations.

The detailed compositions which follow in this report can be used in final radiation calculations for a given system and also provide a survey of important combustion species to be considered in future calculations.

REFERENCES

1. V. R. Stull and G. N. Plass, "Spectral Emissivity of Hydrogen Chloride from 1000-3900 cm^{-1}", Report No. U-461. Aeronutronic, Newport Beach, California, 1959.

2. S. A. Golden, Rocketdyne (Private Communication).

RP-1 - Oxygen

28.571	%	RP-1
71.429	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3395 (^oK)

P_e	2.00	P_e	0.37 (psia)
T_e	2243	T_e	1715 ^oK
ϵ	10.97	ϵ	39.67
I_{sp}	299.0	I_{sp}	335.6 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.5784	28.44	1.5031	27.08
H_2	0.4133	0.83	0.5066	1.02
H	0.0252	0.03	0.0016	0.00
OH	0.0122	0.21	0.0000	0.00
O_2	0.0008	0.03	0.0000	0.00
O	0.0008	0.01	0.0000	0.00
CO	1.2119	33.95	1.1218	31.42
CO_2	0.8295	36.51	0.9195	40.47
Total	4.0723	100.01	4.0526	99.99

RP-1 - Oxygen

29.412	%	RP-1
70.588	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3377 (^oK)

P_e	2.00	P_e	0.37	(psia)
T_e	2125	T_e	1595	^oK
ϵ	10.63	ϵ	37.98	
I_{sp}	299.0	I_{sp}	334.3	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.5411	27.76	1.4307	25.78	
H_2	0.5193	1.05	0.6386	1.29	
H	0.0146	0.01	0.0004	0.00	
OH	0.0046	0.08	0.0000	0.00	
CO	1.3370	37.45	1.2217	34.22	
CO_2	0.7643	33.64	0.8793	38.70	
	4.1809	99.99	4.1708	99.99	Total

RP-1 - Oxygen

30.303	%	RP-1
69.697	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3352 (^oK)

P_e 2.00		P_e 0.37	(psia)
T_e 1997		T_e 1481	^oK
ϵ 10.27		ϵ 36.40	
I_{sp} 298.3		I_{sp} 332.4	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.4824	26.71	1.3404	24.15	
H_2	0.6457	1.30	0.7916	1.60	
H	0.0073	0.01	0.0000	0.00	
OH	0.0013	0.02	0.0000	0.00	
CO	1.4579	40.84	1.3146	36.82	
CO_2	0.7068	31.11	0.8505	37.43	
	4.3014	99.99	4.2971	100.00	Total

RP-1 - Oxygen

31.25	%	RP-1
68.750	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3316 (^oK)

P_e 2.00		P_e 0.37	(psia)
T_e 1866		T_e 1371	^oK
ϵ 9.92		ϵ 34.99	
I_{sp} 296.9		I_{sp} 329.8	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.4050	25.31	1.2321	22.20
H_2	0.7923	1.60	0.9670	1.95
H	0.0031	0.00	0.0000	0.00
OH	0.0004	0.01	0.0000	0.00
CO	1.5739	44.08	1.4005	39.23
CO_2	0.6588	28.99	0.8323	36.63
Total	4.4334	99.99	4.4319	100.01

RP-1 - Oxygen

32.258	%	RP-1
67.742	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3266 (^oK)

P_e	2.00	P_e	0.25	(psia)
T_e	1735	T_e	1175	^oK
ϵ	9.59	ϵ	46.06	
I_{sp}	294.8	I_{sp}	332.4	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.3094	23.59	1.0385	18.71	
H_2	0.9603	1.94	1.2316	2.48	
H	0.0014	0.00	0.0000	0.00	
CO	1.6850	47.20	1.4141	39.61	
CO_2	0.6199	27.28	0.8907	39.20	
	4.5761	100.01	4.5748	100.00	Total

RP-1 - Oxygen

28.571	%	RP-1
71.429	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 3492 (^oK)

P_e	4.00	P_e	0.75	(psia)
T_e	2236	T_e	1696	^oK
ϵ	10.78	ϵ	38.78	
I_{sp}	300.6	I_{sp}	336.8	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.5827	28.51	1.4985	27.00	
H_2	0.4151	0.84	0.5114	1.03	
H	0.0171	0.02	0.0008	0.00	
CO	1.2107	33.91	1.1172	31.29	
CO_2	0.8306	36.57	0.9239	40.66	
OH	0.0085	0.14	0.0000	0.00	
	4.0562	99.99	4.0518	99.98	Total

RP-1 - Oxygen

29.412	%	RP-1
70.588	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 3470 (^oK)

P_e	4.00	P_e	0.75 (psia)
T_e	2114	T_e	1580 ^oK
ϵ	10.43	ϵ	37.21
I_{sp}	300.3	I_{sp}	335.2 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.5415	27.77	1.4257	25.68
H_2	0.5222	1.05	0.6436	1.30
H	0.0096	0.01	0.0004	0.00
CO	1.3355	37.41	1.2167	34.08
CO_2	0.7657	33.70	0.8843	38.92
	4.1745	99.94	4.1707	99.98 Total

RP-1 - Oxygen

30.303	%	RP-1
69.697	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 3440 (^oK)

P_e	4.00	P_e	0.75	(psia)
T_e	1985	T_e	1468	^oK
ϵ	10.09	ϵ	35.77	
I_{sp}	299.4	I_{sp}	333.1	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.4810	26.68	1.3352	24.05	
H_2	0.6485	1.31	0.7972	1.61	
H	0.0047	0.00	0.0000	0.00	
CO	1.4561	40.78	1.3094	36.68	
CO_2	0.7091	31.21	0.8556	37.65	
	4.2994	99.98	4.2974	99.99	Total

RP-1 - Oxygen

31.250	%	RP-1
68.750	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 3397 (^oK)

P_e	4.00	P_e	0.75	(psia)
T_e	1855	T_e	1362	^oK
ϵ	9.76	ϵ	34.45	
I_{sp}	297.8	I_{sp}	330.4	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.4025	25.27	1.2272	22.11	
H_2	0.7952	1.60	0.9719	1.96	
H	0.0022	0.00	0.0000	0.00	
CO	1.5714	44.02	1.3956	39.09	
CO_2	0.6609	29.09	0.8372	36.84	
	4.4324	99.98	4.4319	100.00	Total

RP-1 - Oxygen

32.258	%	RP-1
67.742	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 3339 (^oK)

P_e	4.00	P_e	0.50	(psia)
T_e	1726	T_e	1169	^oK
ϵ	9.46	ϵ	45.51	
I_{sp}	295.4	I_{sp}	332.8	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.3067	23.54	1.0335	18.62	
H_2	0.9626	1.94	1.2366	2.49	
H	0.0009	0.00	0.0000	0.00	
CO	1.6823	47.12	1.4090	39.47	
CO_2	0.6222	27.38	0.8958	39.42	
	4.5747	99.98	4.5748	100.00	Total

RP-1 - Oxygen

28.571	%	RP-1
71.429	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3564 (^oK)

P_e	6.67	P_e	1.25	(psia)
T_e	2229	T_e	1683	^oK
ϵ	10.63	ϵ	38.17	
I_{sp}	301.8	I_{sp}	237.5	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.5845	28.55	1.4953	26.94
H_2	0.4167	0.84	0.5150	1.04
H	0.0126	0.01	0.0008	00.00
CO	1.2096	33.88	1.1140	31.20
CO_2	0.8314	36.59	0.9276	40.82
OH	0.0061	0.10		
Total	4.0609	99.97	4.0527	100.00

RP-1 - Oxygen

29.412	%	RP-1
70.588	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3539 (^oK)

P_e	6.67	1.25	(psia)
T_e	2104	1570	^oK
ϵ	10.30	36.69	
I_{sp}	301.2.	335.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.5412	27.77	1.4224	25.62	
H_2	0.5240	1.06	0.6474	1.30	
H	0.0071	0.01	0.0004	00.00	
CO	1.3345	37.38	1.2134	33.99	
CO_2	0.7670	33.75	0.8880	39.08	
	4.1738	99.97	4.1716	99.99	Total

RP-1 - Oxygen

30.303	%	RP-1
69.697	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3504 (^oK)

P_e	6.67	P_e	1.25	(psia)
T_e	1976	T_e	1460	^oK
ϵ	9.97	ϵ	35.35	
I_{sp}	300.1	I_{sp}	333.6	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.4798	26.66	1.3318	23.99	
H_2	0.6505	1.31	0.8006	1.61	
H	0.0034	00.00	0.0000	00.00	
CO	1.4544	40.74	1.3060	36.58	
CO_2	0.7102	31.26	0.8591	37.81	
	4.2983	99.97	4.2975	99.99	Total

RP-1 - Oxygen

31.250	%	RP-1
68.750	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3456 (^oK)

P_e	6.67	P_e	0.83	(psia)
T_e	1848	T_e	1259	^oK
ϵ	9.66	ϵ	46.65	
I_{sp}	298.3	I_{sp}	336.8	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.4011	25.24	1.1651	20.99	
H_2	0.7970	1.61	1.0339	2.08	
H	0.0013	00.00	0.0000	00.00	
CO	1.5700	43.98	1.3340	37.36	
CO_2	0.6626	29.16	0.8988	39.56	
	4.4320	99.99	4.4318	99.99	Total

RP-1 - Oxygen

32.258	%	RP-1
67.742	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3390 (^oK)

P_e	6.67	P_e	0.83	(psia)
T_e	1721	T_e	1165	^oK
ϵ	9.39	ϵ	45.17	
I_{sp}	264.8	I_{sp}	333.1	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.3052	23.51	1.0302	18.56	
H_2	0.9643	1.94	1.2398	2.50	
H	0.0004	00.00	0.0000	00.00	
CO	1.6808	47.08	1.4058	39.38	
CO_2	0.6235	27.44	0.8989	39.56	
	4.5742	99.97	4.5747	100.00	Total

RP-1 - Oxygen

28.571	%	RP-1
71.429	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3611 (^oK)

P_e	9.33	P_e	1.75	(psia)
T_e	2224	T_e	1675	^oK
ϵ	10.54	ϵ	37.81	
I_{sp}	302.4.	I_{sp}	338.0	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.5854	28.56	1.4932	26.90	
H_2	0.4178	0.84	0.5170	1.04	
H	0.0105	0.01	0.0004	00.00	
CO	1.2091	33.87	1.1119	31.14	
CO_2	0.8323	36.62	0.9295	40.91	
OH	0.0048	0.08	0.0000	00.00	
	4.0599	99.98	4.0520	99.99	Total

RP-1 - Oxygen

29.412	%	RP-1
70.588	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3584 (^oK)

P_e	9.33	P_e	1.75 (psia)
T_e	2098	T_e	1563 ^oK
ϵ	10.21	ϵ	36.38
I_{sp}	301.8.	I_{sp}	336.3. sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.5409	27.76	1.4203	25.59	
H_2	0.5252	1.06	0.6494	1.31	
H	0.0058	0.01	0.0000	00.00	
CO	1.3334	37.35	1.2113	33.93	
CO_2	0.7677	33.79	0.8901	39.17	
	4.1730	99.97	4.1711	100.00	Total

RP-1 - Oxygen

30.303	%	RP-1
69.697	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3546 (^oK)

P_e	9.33	P_e	1.17 (psia)
T_e	1970	T_e	1353 ^oK
ϵ	9.90	ϵ	35.00
I_{sp}	300.6	I_{sp}	340.2 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.4788	26.64	1.3296	23.95
H_2	0.6517	1.31	0.8028	1.62
H	0.0025	00.00	0.0000	00.00
CO	1.4535	40.71	1.3039	36.52
CO_2	0.7115	31.31	0.8612	37.90
Total	4.2980	99.97	4.2975	99.90

RP-1 - Oxygen

31.250	%	RP-1
68.750	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3493 (^oK)

P_e	9.33	P_e	1.17	(psia)
T_e	1843	T_e	1256	^oK
ϵ	9.61	ϵ	46.40	
I_{sp}	298.6	I_{sp}	337.0	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.4002	25.23	1.1629	20.95	
H_2	0.7983	1.61	1.0362	2.09	
H	0.0013	00.00	0.0000	00.00	
CO	1.5687	43.94	1.3318	37.30	
CO_2	0.6640	29.22	0.9010	39.65	
	4.4325	100.00	4.4319	99.99	Total

RP-1 - Oxygen

32.258	%	RP-1
67.742	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3423 (^oK)

P_e	9.33	P_e	1.17	(psia)
T_e	1717	T_e	1163	^oK
ϵ	9.34	ϵ	44.97	
I_{sp}	296.1	I_{sp}	333.2	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.3042	23.50	1.0284	18.53	
H_2	0.9653	1.94	1.2416	2.50	
H	0.0004	00.00	0.0000	00.00	
CO	1.6799	47.05	1.4040	39.33	
CO_2	0.6249	27.50	0.9008	39.64	
	4.5747	99.99	4.5748	100.00	Total

Hydrazine - Oxygen

50	%	N_2H_4
50	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3215 (^oK)

P_e	2.00	P_e	0.37	(psia)
T_e	2077	T_e	1592	^oK
ϵ	10.88	ϵ	39.36	
I_{sp}	310.7	I_{sp}	348.6	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.0505	54.96	3.1155	56.13	
H_2	0.0581	0.12	0.0042	0.01	
H	0.0038	00.00	0.0000	00.00	
OH	0.0198	0.34	0.0009	0.02	
O_2	0.0245	0.79	0.0038	0.12	
O	0.0014	0.02	0.0000	00.00	
NO	0.0047	0.14	0.0005	0.01	
N_2	1.5576	43.64	1.5601	43.71	
	4.7205	100.01	4.6850	100.00	Total

Hydrazine - Oxygen

52.632	%	N_2H_4
47.368	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3206 (^oK)

P_e	2.00	P_e	0.37	(psia)
T_e	1928	T_e	1396	^oK
ϵ	10.34	ϵ	35.84	
I_{sp}	313.0.	I_{sp}	348.7.	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.9577	53.29	2.9600	53.33
H_2	0.3239	0.65	0.3242	0.65
H	0.0034	00.00	0.0000	00.00
OH	0.0025	0.04	0.0000	00.00
N_2	1.6420	46.01	1.6421	46.01
	4.9295	99.99	4.9263	99.99 Total

Hydrazine - Oxygen

55.556	%	N_2H_4
44.444	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3168 (^oK)

P_e	2.00	P_e	0.25	(psia)
T_e	1722	T_e	1119	^oK
ϵ	9.68	ϵ	44.68	
I_{sp}	312.2	I_{sp}	351.8	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.7774	50.04	2.7776	50.04	
H_2	0.6892	1.39	0.6891	1.39	
H	0.0010	00.00	0.0000	00.00	
OH	0.0005	0.01	0.0000	00.00	
N_2	1.7335	48.57	1.7334	48.56	
	5.2016	100.01	5.2001	100.00	Total

Hydrazine - Oxygen

58.824	%	N_2H_4
41.176	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3089 (^oK)

P_e	2.00	P_e	0.25	(psia)
T_e	1525	T_e	967	^oK
ϵ	9.14	ϵ	41.38	
I_{sp}	309.1	I_{sp}	346.3	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.5732	46.36	2.5737	46.37	
H_2	1.0974	2.21	1.0974	2.21	
N_2	1.8353	51.42	1.8353	51.42	
	5.5059	99.99	5.5064	100.00	Total

Hydrazine - Oxygen

62.5	%	N_2H_4
37.5	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 2954 (^oK)

P_e	1.50	P_e	0.25 (psia)
T_e	1252	T_e	824 ^oK
ϵ	10.66	ϵ	38.55
I_{sp}	310.0	I_{sp}	338.7 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.3438	42.23	2.3438	42.23	
H_2	1.5568	3.14	1.5568	3.14	
N_2	1.9500	54.63	1.9500	54.63	
	5.8506	100.00	5.8506	100.00	Total

Hydrazine - Oxygen

50	%	N_2H_4
50	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 3294 (^oK)

P_e	4.00	P_e	0.75	(psia)
T_e	2076	T_e	1576	^oK
ϵ	10.73	ϵ	38.56	
I_{sp}	312.2	I_{sp}	349.7	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.0653	55.22	3.1172	56.16	
H_2	0.0462	0.09	0.0028	0.01	
H	0.0024	00.00	0.0000	00.00	
OH	0.0156	0.26	0.0009	0.02	
O_2	0.0198	0.63	0.0033	0.10	
NO	0.0042	0.13	0.0005	0.01	
N_2	1.5581	43.65	1.5598	43.70	
O	0.0009	0.02	0.0000	00.00	
	4.7124	100.00	4.6845	100.00	Total

Hydrazine - Oxygen

52.632	%	N_2H_4
47.368	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 3283 (^oK)

P_e 4.00	P_e 0.75	(psia)
T_e 1915	T_e 1383	^oK
ϵ 10.16	ϵ 35.20	
I_{sp} 314.2	I_{sp} 349.4	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.9590	53.31	2.9600	53.33	
H_2	0.3238	0.65	0.3242	0.65	
H	0.0020	00.00	0.0000	00.00	
OH	0.0015	0.03	0.0000	00.00	
N_2	1.6422	46.01	1.6421	46.01	
	4.9285	100.00	4.9263	99.99	Total

Hydrazine - Oxygen

55.556	%	N_2H_4
44.444	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 3239 (^oK)

P_e	4.00	0.50	(psia)
T_e	1712	1112	^oK
ϵ	9.54	44.05	
I_{sp}	313.0	352.2	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.7774	50.04	2.7776	50.04	
H_2	0.6892	1.39	0.6891	1.39	
H	0.0005	00.00	0.0000	00.00	
OH	0.0005	0.01	0.0000	00.00	
N_2	1.7335	48.57	1.7334	48.56	
	5.20111	100.01	5.2000	100.00	Total

Hydrazine - Oxygen

58.824	%	N_2H_4
41.176	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 3146 (^oK)

P_e	4.00	P_e	0.50	(psia)
T_e	1519	T_e	962	^oK
ϵ	9.05	ϵ	40.99	
I_{sp}	309.6	I_{sp}	346.6	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.5732	46.36	2.5737	46.37	
H_2	1.0974	2.21	1.0974	2.21	
N_2	1.8353	51.42	1.8353	51.42	
	5.5059	99.99	5.5064	100.00	Total

Hydrazine - Oxygen

62.5	%	N_2H_4
37.5	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 2993 (^oK)

P_e	3.00	P_e	0.50	(psia)
T_e	1249	T_e	822	^oK
ϵ	10.61	ϵ	38.36	
I_{sp}	310.2	I_{sp}	338.8	sec optimum

Combustion Gases	mol/100g.	wt %	mol/100g	wt %	
H_2O	2.3438	42.23	2.3435	42.22	
H_2	1.5568	3.14	1.5567	3.14	
N_2	1.9500	54.63	1.9498	54.63	
	5.8506	100.00	5.8500	99.99	Total

Hydrazine - Oxygen

47.619	%	N_2H_4
52.381	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3342 (^oK)

P_e	6.67	P_e	1.25	(psia)
T_e	2017	T_e	1492	^oK
ϵ	10.45	ϵ	36.87	
I_{sp}	308.1	I_{sp}	343.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.9548	53.23	2.9712	53.53
H_2	.0083	.02	0.0000	00.00
H	.0005	00.00	0.0000	00.00
OH	.0166	.28	.0009	.02
O_2	.1459	4.67	.1502	4.81
O	.0009	.01	.0000	0.00
NO	.0097	.29	.0014	.04
N_2	1.4809	41.49	1.4849	41.60
Total	4.6176	99.99	4.6086	100.00

Hydrazine - Oxygen

50	%	N_2H_4
50	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3352 (^oK)

P_e	6.67	P_e	1.25	(psia)
T_e	2074	T_e	1564	^oK
ϵ	10.62	ϵ	37.99	
I_{sp}	313.2	I_{sp}	350.4	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	3.0743	55.39	3.1181	56.18
H_2	.0386	.08	.0019	00.00
H	.0019	00.00	.0000	00.00
OH	.0132	.22	.0009	.02
O_2	.0165	.53	.0028	.09
O	.0005	.01	.0000	00.00
NO	.0038	.11	.0005	.01
N_2	1.5583	43.66	1.5598	43.70
Total	4.7070	100.00	4.6840	100.00

Hydrazine - Oxygen

52.632	%	N_2H_4
47.368	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3339 (^oK)

P_e	6.67	P_e	1.25	(psia)
T_e	1905	T_e	1375	^oK
ϵ	10.03	ϵ	34.74	
I_{sp}	315.0	I_{sp}	349.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.9592	53.31	2.9600	53.33	
H_2	0.3238	0.65	0.3242	0.65	
H	0.0015	00.00	0.0000	00.00	
OH	0.0010	0.02	0.0000	00.00	
N_2	1.6420	46.01	1.6421	46.01	
	4.9275	99.99	4.9263	99.99	Total

Hydrazine - Oxygen

55.556	%	N_2H_4
44.444	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3289 (^oK)

P_e	6.67	P_e	0.83 (psia)
T_e	1705	T_e	1107 ^oK
ϵ	9.45	ϵ	43.64
I_{sp}	313.5	I_{sp}	352.5 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.7771	50.03	2.776	50.04	
H_2	0.6891	1.39	0.6891	1.39	
H	0.0005	00.00	0.0000	00.00	
OH	0.0005	0.01	0.0000	00.00	
N_2	1.7334	48.56	1.7334	48.56	
	5.2006	99.99	5.2001	99.99	Total

Hydrazine - Oxygen

58.824 % N_2H_4

41.176 % LOX

%

%

P_c 500 (psia)

T_c 3185 (^oK)

P_e	6.67	0.83	(psia)
T_e	1515	960	^oK
ϵ	9.00	40.75	
I_{sp}	309.9	346.7	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.5732	46.36	2.5737	46.37
H_2	1.0974	2.21	1.0974	2.21
N_2	1.8353	51.42	1.8353	51.42
Total	5.5059	99.99	5.5064	100.00

Hydrazine - Oxygen

47.619	%	N_2H_4
52.381	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3379 (^oK)

P_e	9.33	P_e	1.75	(psia)
T_e	2013	T_e	1485	^oK
ϵ	10.38	ϵ	36.56	
I_{sp}	308.7	I_{sp}	344.3	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.9571	53.28	2.9712	53.53	
H_2	0.0065	0.01	0.0000	00.00	
H	0.0005	00.00	0.0000	00.00	
OH	0.0152	0.26	0.0009	0.02	
O_2	0.1454	4.65	0.1502	4.81	
O	0.0009	0.01	0.0000	0.00	
NO	0.0092	0.28	0.0014	0.04	
N_2	1.4809	41.49	1.4849	41.60	
	4.6157	99.98	4.6086	100.00	Total

Hydrazine - Oxygen

50	%	N_2H_4
50	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3390 (^oK)

P_e	9.33	P_e	1.75	(psia)
T_e	2073	T_e	1557	^oK
ϵ	10.55	ϵ	37.65	
I_{sp}	313.9	I_{sp}	350.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.0798	55.49	3.1183	56.18	
H_2	0.0339	0.07	0.0014	00.00	
H	0.0014	00.00	0.0000	00.00	
OH	0.0118	0.20	0.0005	0.01	
O_2	0.0146	0.47	0.0028	0.09	
O	0.0005	0.01	0.0000	00.00	
NO	0.0038	0.11	0.0005	0.01	
N_2	1.5583	43.66	1.5601	43.71	
	4.7040	100.01	4.6835	100.00	Total

<u>Hydrazine-Oxygen</u>

52.632	%	N_2H_4
47.368	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3376 (^oK)

P_e	9.33	P_e	1.75	(psia)
T_e	1899	T_e	1370	^oK
ϵ	9.95	ϵ	34.49	
I_{sp}	315.4	I_{sp}	350.2	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.9597	53.32	2.9600	53.33	
H_2	0.3238	0.65	0.3242	0.65	
H	0.0015	00.00	0.0000	00.00	
OH	0.0010	0.02	0.0000	00.00	
N_2	1.6420	46.01	1.6421	46.01	
	4.9279	100.00	4.9263	99.99	Total

Hydrazine - Oxygen

55.556	%	N_2H_4
44.444	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3321 (^oK)

P_e	9.33	1.17	(psia)
T_e	1701	1104	^oK
ϵ	9.39	43.38	
I_{sp}	313.8.	352.7.	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.7771	50.03	2.7776	50.04	
H_2	0.6891	1.39	0.6891	1.39	
H	0.0005	00.00	0.0000	00.00	
OH	0.0005	0.01	0.0000	00.00	
N_2	1.7334	48.56	1.7334	48.56	
	5.2006	99.99	5.2001	99.99	Total

Hydrazine - Oxygen

58.824	%	N_2H_4
41.176	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3209 (^oK)

P_e	9.33	P_e	1.17	(psia)
T_e	1513	T_e	958	^oK
ϵ	8.97	ϵ	40.61	
I_{sp}	310.0.	I_{sp}	346.8	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H2O	2.5732	46.36	2.5734	46.36	
H_2	1.0974	2.21	1.0973	2.21	
N_2	1.8353	51.42	1.8351	51.42	
	5.5059	99.99	5.5058	99.99	Total

UDMH - Oxygen

38.462	%	UDMH
61.538	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3341 (^oK)

P_e	2.00	P_e	0.37	(psia)
T_e	2121	T_e	1585	^oK
ϵ	10.70	ϵ	38.03	
I_{sp}	308.8	I_{sp}	345.5	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.0175	36.35	1.9280	34.74	
H_2	0.5317	1.07	0.6312	1.27	
H	0.0148	0.01	0.0004	00.00	
OH	0.0058	0.10	0.0000	00.00	
O_2	0.0004	0.01	0.0000	00.00	
NO	0.0004	0.01	0.0000	00.00	
N_2	0.6399	17.93	0.6397	17.92	
CO	0.7382	20.68	0.6419	17.98	
CO_2	0.5415	23.83	0.6379	28.07	
	4.4904	99.99	4.4792	99.98	Total

UDMH - Oxygen

40	%	UDMH
60	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3314 (^oK)

P_e	2.00	P_e	0.37 (psia)
T_e	1964	T_e	1444 ^oK
ϵ	10.23	ϵ	35.99
I_{sp}	282.1	I_{sp}	343.6 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.9312	34.79	1.8048	32.52	
H_2	0.7273	1.47	0.8572	1.73	
OH	0.0014	0.02	0.0000	00.00	
H	0.0065	0.01	0.0000	00.00	
N_2	0.6653	18.64	0.6657	18.65	
CO	0.8448	23.66	0.7170	20.08	
CO_2	0.4863	21.40	0.6140	27.02	
	4.6629	99.99	4.6588	100.00	Total

UDMH - Oxygen

41.667	%	UDMH
58.333	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3269 (°K)

P_e	2.00	P_e	0.37	(psia)
T_e	1803	T_e	1311	°K
ϵ	9.78	ϵ	34.18	
I_{sp}	308.4	I_{sp}	340.6	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.8129	32.66	1.6514	29.75
H_2	0.9586	1.93	1.1215	2.26
H	0.0019	00.00	0.0000	00.00
N_2	0.6931	19.42	0.6935	19.43
CO	0.9407	26.35	0.7789	21.82
CO_2	0.4461	19.63	0.6076	26.74
Total	4.8533	99.99	4.8529	100.00

UDMH - Oxygen

43.478	%	UDMH
56.522	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3203 (^oK)

P_e 2.00		P_e 0.25	(psia)
T_e 1644		T_e 1096	^oK
ϵ 9.38		ϵ 44.47	
I_{sp} 304.6		I_{sp} 342.6	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.6660	30.02	1.4012	25.24	
H_2	1.2270	2.47	1.4923	3.01	
H	0.0005	0.00	0.0000	00.00	
N_2	0.7231	20.26	0.7236	20.27	
CO	1.0270	28.77	0.7621	21.35	
CO_2	0.4198	18.48	0.6846	30.13	
	5.0634	100.00	5.0638	100.00	Total

UDMH - Oxygen

45.455	%	UDMH
54.545	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3108 (^oK)

P_e	2.00	P_e	0.25 (psia)
T_e	1489	T_e	987 ^oK
ϵ	9.03	ϵ	42.69
I_{sp}	300.8	I_{sp}	337.2 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.4908	26.86	1.1716	21.11
H_2	1.5342	3.09	1.8535	3.74
N_2	0.7565	21.19	0.7565	21.19
CO	1.1070	31.01	0.7878	22.07
CO_2	0.4055	17.85	0.7248	31.90
	5.2941	100.00	5.2941	100.01 Total

UDMH - Oxygen

37.037	%	UDMH
62.963	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 2164 (^oK)

P_e	4.00	0.75	(psia)
T_e	2257	1715	^oK
ϵ	10.93	39.32	
I_{sp}	309.8	347.6	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.0734	37.35	2.0181	36.36
H_2	0.3752	0.76	0.4461	0.90
H	0.0186	0.02	0.0009	00.00
OH	0.0139	0.24	0.0000	00.00
O_2	0.0013	0.04	0.0000	00.00
O	0.0004	0.01	0.0000	00.00
NO	0.0009	0.03	0.0000	00.00
N_2	0.6156	17.25	0.6161	17.26
CO	0.6212	17.40	0.5483	15.36
CO_2	0.6113	26.90	0.6842	30.11
	4.3318	100.00	4.3135	99.99 Total

UDMH - Oxygen

38.462 % UDMH
61.538 % LOX

P_c 300 (psia)
T_c 3431 (°K)

P_e	4.00	0.75	(psia)
T_e	2110	1569	°K
ϵ	10.49	37.22	
I_{sp}	310.3	346.5	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.0189	36.37	1.9236	34.65
H_2	0.5339	1.08	0.6357	1.28
H	0.0099	0.01	0.0004	00.00
OH	0.0040	0.07	0.0000	00.00
N_2	0.6398	17.92	0.6401	17.93
CO	0.7371	20.65	0.6374	17.85
CO_2	0.5429	23.89	0.6424	28.27
Total	4.4865	99.99	4.4796	99.98

UDMH - Oxygen

40	%	UDMH
60	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 3398 (^oK)

P_e	4.00	0.75	(psia)
T_e	1952	1432	^oK
ϵ	10.05	35.36	
I_{sp}	309.7	344.3	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.9297	34.77	1.8002	32.43
H_2	0.7299	1.47	0.8619	1.74
H	0.0042	0.00	0.0000	00.00
OH	0.0009	0.02	0.0000	00.00
N_2	0.6656	18.65	0.6657	18.65
CO	0.8427	23.61	0.7123	19.95
CO_2	0.4880	21.48	0.6187	27.23
	4.6612	100.00	4.6588	100.00 Total

UDMH - Oxygen

41.667 % UDMH
58.333 % LOX
%
%

P_c 300 (psia)
T_c 3346 (^oK)

P_e	4.00	P_e	0.50 (psia)
T_e	1793	T_e	1205 ^oK
ϵ	9.64	ϵ	45.94
I_{sp}	308.0	I_{sp}	347.4 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.8108	32.62	1.5922	28.69
H_2	0.9614	1.94	1.1807	2.38
H	0.0015	00.00	0.0000	00.00
N_2	0.6931	19.42	0.6935	19.43
CO	0.9382	26.28	0.7197	20.16
CO_2	0.4484	19.74	0.6668	29.35
Total	4.8534	100.00	4.8529	100.01

UDMH - Oxygen

43.478	%	UDMH
56.522	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 3269 (^oK)

P_e	4.00	P_e	0.50	(psia)
T_e	1636	T_e	1091	^oK
ϵ	9.27	ϵ	44.01	
I_{sp}	305.2	I_{sp}	342.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.6640	29.98	1.3966	25.16	
H_2	1.2295	2.48	1.4969	3.02	
H	0.0005	00.00	0.0000	00.00	
N_2	0.7231	20.26	0.7236	20.27	
CO	1.0249	28.71	0.7581	21.23	
CO_2	0.4218	18.56	0.6887	30.31	
	5.0639	99.99	5.0639	99.99	Total

UDMH - Oxygen

35.714	%	UDMH
64.286	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3532 (^oK)

P_e	6.67	P_e	1.25	(psia)
T_e	2375	T_e	1852	^oK
ϵ	11.15	ϵ	40.88	
I_{sp}	310.0	I_{sp}	348.8	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.0966	37.77	2.0814	37.50	
H_2	0.2554	0.51	0.2942	0.59	
H	0.0218	0.02	0.0021	00.00	
OH	0.0277	0.47	0.0008	0.01	
O_2	0.0063	0.20	0.0000	00.00	
O	0.0021	0.03	0.0000	00.00	
NO	0.0029	0.09	0.0000	00.00	
N_2	0.5926	16.60	0.5942	16.65	
CO	0.5008	14.03	0.4415	12.37	
CO_2	0.6874	30.25	0.7469	32.87	
	4.1935	99.97	4.1611	99.99	Total

UDMH - Oxygen

37.037	%	UDMH
62.963	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 2155 (^oK)

P_e	6.67	P_e	1.25	(psia)
T_e	2252	T_e	1701	^oK
ϵ	10.79	ϵ	38.69	
I_{sp}	311.1	I_{sp}	348.4	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.0774	37.43	2.0155	36.31	
H_2	0.3752	0.76	0.4491	0.91	
H	0.0143	0.01	0.0009	00.00	
OH	0.0104	0.18	0.0000	00.00	
O_2	0.0009	0.03	0.0000	00.00	
O	0.0004	0.01	0.0000	00.00	
NO	0.0009	0.03	0.0000	00.00	
N_2	0.6157	17.25	0.6160	17.26	
CO	0.6200	17.37	0.5457	15.29	
CO_2	0.6123	26.95	0.6868	30.23	
	4.3275	100.02	4.3141	100.00	Total

UDMH - Oxygen

38.462	%	UDMH
61.538	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3498 (^oK)

P_e	6.67	P_e	1.25 (psia)
T_e	2101	T_e	1558 ^oK
ϵ	10.36	ϵ	36.71
I_{sp}	311.2	I_{sp}	347.1 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.0194	36.38	1.9209	34.61
H_2	0.5355	1.08	0.6388	1.29
H	0.0072	0.01	0.0000	00.00
OH	0.0027	0.05	0.0000	00.00
N_2	0.6400	17.93	0.6401	17.93
CO	0.7359	20.61	0.6343	17.77
CO_2	0.5440	23.94	0.6455	28.41
Total	4.4846	100.00	4.4796	100.01

UDMH - Oxygen

40	%	UDMH
60	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3460 (^oK)

P_e	6.67	P_e	1.25	(psia)
T_e	1943	T_e	1424	^oK
ϵ	9.93	ϵ	34.93	
I_{sp}	310.4	I_{sp}	344.8	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.9285	34.74	1.7969	32.37	
H_2	0.7317	1.48	0.8651	1.74	
H	0.0028	00.00	0.0000	00.00	
OH	0.0005	0.01	0.0000	00.00	
N_2	0.6655	18.64	0.6657	18.65	
CO	0.8417	23.58	0.7095	19.87	
CO_2	0.4893	21.54	0.6215	27.35	
	4.6599	99.99	4.6588	99.98	Total

UDMH - Oxygen

41.667	%	UDMH
58.333	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3401 (^oK)

P_e	6.67	P_e	0.83 (psia)
T_e	1786	T_e	1200 ^oK
ϵ	9.54	ϵ	45.53
I_{sp}	308.5	I_{sp}	347.7 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.8093	32.60	1.5893	28.63	
H_2	0.9629	1.94	1.1836	2.39	
H	0.0010	0.00	0.0000	00.00	
N_2	0.6931	19.42	0.6935	19.43	
CO	0.9367	26.24	0.7168	20.08	
CO_2	0.4499	19.80	0.6702	29.50	
	4.8528	100.00	4.8534	100.03	Total

UDMH - Oxygen

35.714 % UDMH
64.286 % LOX
%
%

P_c 700 (psia)
T_c 3579 (^oK)

P_e	9.33	P_e	1.75 (psia)
T_e	2378	T_e	1842 ^oK
ϵ	11.08	ϵ	40.44
I_{sp}	310.8	I_{sp}	349.4 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.1021	37.87	2.0799	37.47
H_2	0.2538	0.51	0.2954	0.60
H	0.0184	0.02	0.0017	00.00
OH	0.0239	0.41	0.0008	0.01
O_2	0.0046	0.15	0.0000	00.00
O	0.0013	0.02	0.0000	00.00
NO	0.0025	0.08	0.0000	00.00
N_2	0.5930	16.61	0.5942	16.65
CO	0.4984	13.96	0.4402	12.33
CO_2	0.6902	30.38	0.7485	32.94
	4.1882	100.01	4.1607	100.00 Total

UDMH - Oxygen

37.037	%	UDMH
62.963	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3566 (^oK)

P_e	9.33	1.75	(psia)
T_e	2247	1693	^oK
ϵ	10.69	38.29	
I_{sp}	311.8	348.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.0792	37.46	2.0136	36.28
H_2	0.3758	0.76	0.4508	0.91
H	0.0117	0.01	0.0004	00.00
OH	0.0082	0.14	0.0000	00.00
O_2	0.0004	0.01	0.0000	00.00
O	0.0004	0.01	0.0000	00.00
NO	0.0004	0.01	0.0000	00.00
N_2	0.6158	17.25	0.6160	17.26
CO	0.6193	17.35	0.5440	15.24
CO_2	0.6132	26.99	0.6885	30.30
Total	4.3244	99.99	4.3133	99.99

UDMH - Oxygen

38.462	%	UDMH
61.538	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3542 (°K)

P_e	9.33	P_e	1.75	(psia)
T_e	2094	T_e	1552	°K
ϵ	10.26	ϵ	36.37	
I_{sp}	311.8	I_{sp}	347.5	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.0189	36.37	1.9191	34.57	
H_2	0.5362	1.08	0.6406	1.29	
H	0.0058	0.01	0.0000	00.00	
OH	0.0022	0.04	0.0000	00.00	
N_2	0.6398	17.92	0.6401	17.93	
CO	0.7353	20.60	0.6325	17.72	
CO_2	0.5443	23.95	0.6473	28.49	
	4.4826	99.97	4.4796	100.00	Total

UDMH - Oxygen

40	%	UDMH
60	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3500 (^oK)

P_e	9.33	P_e	1.75	(psia)
T_e	1937	T_e	1419	^oK
ϵ	9.86	ϵ	34.69	
I_{sp}	310.9	I_{sp}	345.1	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.9278	34.73	1.7955	32.35	
H_2	0.7326	1.48	0.8670	1.75	
H	0.0023	00.00	0.0000	00.00	
OH	0.0005	00.01	0.0000	00.00	
N_2	0.6654	18.64	0.6657	18.65	
CO	0.8407	23.55	0.7077	19.82	
CO_2	0.4902	21.58	0.6234	27.43	
	4.6595	99.99	4.6593	100.00	Total

UDMH - Oxygen

41.667	%	UDMH
58.333	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3437 (^oK)

P_e	9.33	1.17	(psia)
T_e	1781	1197	^oK
ϵ	9.49	45.27	
I_{sp}	308.8	347.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.8084	32.58	1.5874	28.60	
H_2	0.9639	1.94	1.1856	2.39	
H	0.0010	00.00	0.0000	00.00	
N_2	0.6931	19.42	0.6935	19.43	
CO	0.9362	26.22	0.7148	20.02	
CO_2	0.4504	19.82	0.6721	29.58	
	4.8528	99.98	4.8534	100.02	Total

Hydrazine - UDMH - Oxygen

43.478	%	N_2H_4 - UDMH (50-50)
56.522	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3295 (^oK)

P_e	2.00	P_e	0.37	(psia)
T_e	2127	T_e	1590	^oK
ϵ	10.83	ϵ	38.45	
I_{sp}	310.6	I_{sp}	347.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.4045	43.32	2.3538	42.41
H_2	0.3878	0.78	0.4494	0.91
H	0.0133	0.01	0.0005	00.00
OH	0.0087	0.15	0.0000	00.00
O_2	0.0005	0.01	0.0000	00.00
O	0.0005	0.01	0.0000	00.00
NO	0.0009	0.03	0.0000	00.00
N_2	1.0395	29.12	1.0399	29.13
CO	0.3297	9.23	0.2685	7.52
CO_2	0.3938	17.33	.4549	20.02
Total	4.5791	99.99	4.5670	99.99

Hydrazine - UDMH - Oxygen

45.455	%	N_2H_4 - UDMH (50-50)
54.545	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3271 (^oK)

P_e	2.00	P_e	0.37	(psia)
T_e	1952	T_e	1429	^oK
ϵ	1028	ϵ	36.01	
I_{sp}	310.8	I_{sp}	346.1	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.3100	41.62	2.2230	40.05
H_2	0.6173	1.24	0.7076	1.43
H	0.0053	0.01	0.0000	0.00
OH	0.0014	0.02	0.0000	0.00
N_2	1.0869	30.45	1.0872	30.46
CO	0.4157	11.64	0.3271	9.16
CO_2	0.3406	14.99	0.4292	18.89
Total	4.7772	99.97	4.7741	99.99

Hydrazine - UDMH - Oxygen

47.619	%	N_2H_4 - UDMH (50-50)
52.381	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3227 (^oK)

P_e	2.00	0.25	(psia)
T_e	1772	1181	^oK
ϵ	9.76	46.09	
I_{sp}	309.5	349.3	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.1747	39.18	2.0178	36.35	
H_2	0.8945	1.80	1.0524	2.12	
H	0.0015	00.00	0.0000	00.00	
N_2	1.1392	31.91	1.1389	31.91	
CO	0.4863	13.62	0.3291	9.22	
CO_2	0.3062	13.47	0.4637	20.41	
	5.0024	99.98	5.0019	100.01	Total

Hydrazine - UDMH - Oxygen

50	%	N_2H_4 - UDMH (50-50)
50	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 3153 (^oK)

P_e	2.00	P_e	0.25	(psia)
T_e	1596	T_e	1051	^oK
ϵ	9.29	ϵ	43.58	
I_{sp}	306.7	I_{sp}	344.5	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.0052	36.13	1.8035	32.49	
H_2	1.2185	2.46	1.4207	2.86	
H	0.0005	00.00	0.0000	00.00	
N_2	1.1959	33.50	1.1959	33.50	
CO	0.5446	15.26	0.3424	9.59	
CO_2	0.2873	12.64	0.4895	21.54	
	5.2520	99.99	5.2520	99.98	Total

Hydrazine - UDMH - Oxygen

52.632	%	N_2H_4 - UDMH (50-50)
47.368	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 2672 (^oK)

P_e	1.50	P_e	0.25	(psia)
T_e	1343	T_e	930	^oK
ϵ	10.97	ϵ	41.57	
I_{sp}	308.5	I_{sp}	338.3	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.7763	32.00	1.5474	27.88
H_2	1.6171	3.26	1.8459	3.72
N_2	1.2588	35.27	1.2588	35.27
CO	0.5678	15.90	0.3383	9.48
CO_2	0.3079	13.55	0.5374	23.65
Total	5.5279	99.98	5.5279	100.00

Hydrazine - UDMH - Oxygen

41.667 % N_2H_4 - UDMH (50-50)
58.333 % LOX
%
%

P_c 300 (psia)
T_c 3394 (^oK)

P_e	4.00	P_e	0.75 (psia)
T_e	2267	T_e	1743 ^oK
ϵ	11.11	ϵ	40.29
I_{sp}	310.8	I_{sp}	349.4 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.4507	44.15	2.4450	44.05	
H_2	0.2167	0.44	0.2407	0.49	
H	0.0150	0.02	0.0009	00.00	
OH	0.0229	0.39	0.0004	00.00	
O_2	0.0062	0.20	0.0000	00.00	
O	0.0013	0.02	0.0000	00.00	
NO	0.0031	0.09	0.0000	00.00	
N_2	0.9950	27.88	0.9967	27.92	
CO	0.2312	6.48	0.1865	5.22	
CO_2	0.4620	20.33	0.5069	22.31	
	4.4041	100.00	4.3771	99.99	Total

Hydrazine - UDMH - Oxygen

43.478	%	N_2H_4 - UDMH (50-50)
56.522	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 3381 (^oK)

P_e	4.00	P_e	0.75	(psia)
T_e	2116	T_e	1573	^oK
ϵ	10.63	ϵ	37.64	
I_{sp}	312.1	I_{sp}	348.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.4077	43.38	2.3511	42.36	
H_2	0.3889	0.78	0.4521	0.91	
H	0.0087	0.01	0.0005	00.00	
OH	0.0055	0.09	0.0000	00.00	
O_2	0.0005	0.01	0.0000	00.00	
NO	0.0005	0.01	0.0000	00.00	
N_2	1.0398	29.13	1.0399	29.13	
CO	0.3289	9.21	0.2658	7.45	
CO_2	0.3948	17.38	0.4576	20.14	
	4.5752	100.00	4.5670	99.99	Total

Hydrazine - UDMH - Oxygen

45.455	%	N_2H_4 - UDMH (50-50)
54.545	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 3353 (^oK)

P_e	4.00	P_e	0.75	(psia)
T_e	1938	T_e	1417	^oK
ϵ	10.09	ϵ	35.36	
I_{sp}	312.0	I_{sp}	346.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.3096	41.61	2.2208	40.00	
H_2	0.6191	1.25	0.7104	1.43	
H	0.0033	0.00	0.0000	0.00	
OH	0.0010	0.02	0.0000	0.00	
N_2	1.0872	30.46	1.0872	30.46	
CO	0.4142	11.60	0.3237	9.07	
CO_2	0.3420	15.50	0.4326	19.04	
	4.7763	99.99	4.7741	100.00	Total

Hydrazine - UDMH - Oxygen

47.619	%	N_2H_4 - UDMH (50-50)
52.381	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 3301 (^oK)

P_e	4.00	P_e	0.50	(psia)
T_e	1761	T_e	1173	^oK
ϵ	9.61	ϵ	45.44	
I_{sp}	310.3	I_{sp}	349.8	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.1735	39.16	2.0148	36.30	
H_2	0.8964	1.81	1.0559	2.13	
H	0.0010	0.00	0.0000	00.00	
N_2	1.1390	31.91	1.1389	31.91	
CO	0.4847	13.58	0.3256	9.12	
CO_2	0.3076	13.54	0.4667	20.54	
	5.0024	100.00	5.0019	100.00	Total

Hydrazine - UDMH - Oxygen

50 % N_2H_4 - UDMH (50-50)
50 % LOX
%
%

P_c 300 (psia)
T_c 3215 (^oK)

P_e	4.00	P_e	0.50 (psia)
T_e	1589	T_e	1046 ^oK
ϵ	9.20	ϵ	43.14
I_{sp}	307.2	I_{sp}	344.8 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.0042	36.11	1.8004	32.44
H_2	1.2200	2.46	1.4233	2.87
N_2	1.1959	33.50	1.1959	33.50
CO	0.5431	15.21	0.3398	9.52
CO_2	0.2889	12.71	0.4921	21.66
Total	5.2520	99.99	5.2515	99.99

Hydrazine - UDMH - Oxygen

41.667 % N_2H_4 - UDMH (50-50)
58.333 % LOX
%
%

P_c 500 (psia)
T_c 3460 (^oK)

P_e	6.67	P_e	1.25 (psia)
T_e	2267	T_e	1728 ^oK
ϵ	10.98	ϵ	39.61
I_{sp}	312.1	I_{sp}	350.3 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.4584	44.29	2.4437	44.03
H_2	0.2133	0.43	0.2420	0.49
H	0.0119	0.01	0.0009	00.00
OH	0.0180	0.31	0.0004	0.01
O_2	0.0040	0.13	0.0000	00.00
O	0.0009	0.01	0.0000	00.00
NO	0.0022	0.07	0.0000	00.00
N_2	0.9955	27.89	0.9967	27.92
CO	0.2282	6.39	0.1852	5.19
CO_2	0.4652	20.47	0.5082	22.37
Total	4.3975	100.00	4.3771	100.01

Hydrazine - UDMH - Oxygen

43.478	%	N_2H_4 - UDMH (50-50)
56.522	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3445 (^oK)

P_e	6.67	P_e	1.25 (psia)
T_e	2107	T_e	1562 ^oK
ϵ	10.49	ϵ	37.09
I_{sp}	313.1	I_{sp}	349.6 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.4088	43.40	2.3492	42.32	
H_2	0.3896	0.79	0.4540	0.92	
H	0.0064	0.01	0.0000	00.00	
OH	0.0041	0.07	0.0000	00.00	
NO	0.0005	0.01	0.0000	00.00	
N_2	1.0398	29.13	1.0399	29.13	
CO	0.3279	9.18	0.2640	7.39	
CO_2	0.3955	17.41	0.4599	20.24	
	4.5726	100.00	4.5670	100.00	Total

Hydrazine - UDMH - Oxygen

45.455	%	N_2H_4 - UDMH (50-50)
54.545	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3413 (^oK)

P_e	6.67	P_e	1.25	(psia)
T_e	1929	T_e	1409	^oK
ϵ	9.97	ϵ	34.93	
I_{sp}	312.7	I_{sp}	347.4	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.3087	41.59	2.2183	39.96	
H_2	0.6204	1.25	0.7128	1.44	
H	0.0024	0.00	0.0000	0.00	
OH	0.0005	0.01	0.0000	0.00	
N_2	1.0870	30.45	1.0872	30.46	
CO	0.4131	11.57	0.3218	9.01	
CO_2	0.3429	15.09	0.4345	19.12	
	4.7750	99.96	4.7746	99.99	Total

Hydrazine - UDMH - Oxygen

47.619	%	N_2H_4 - UDMH (40-50)
52.381	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3354 (^oK)

P_e	6.67	0.83	(psia)
T_e	1754	1168	^oK
ϵ	9.52	45.01	
I_{sp}	310.8	350.1	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.1725	39.14	2.0123	36.25
H_2	0.8979	1.81	1.0579	2.13
H	0.0010	0.00	0.0000	0.00
N_2	1.1390	31.91	1.1389	31.91
CO	0.4832	13.54	0.3236	9.06
CO_2	0.3092	13.61	0.4692	20.65
Total	5.0029	100.01	5.0019	100.00

Hydraziné - UDMH - Oxygen

50	%	N_2H_4 - UDMH (50-50)
50	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3259 (^oK)

P_e	6.67	P_e	0.83 (psia)
T_e	1584	T_e	1043 ^oK
ϵ	9.14	ϵ	42.88
I_{sp}	307.5	I_{sp}	345.0 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.0031	36.09	1.7988	32.41
H_2	1.2206	2.46	1.4254	2.87
N_2	1.1959	33.50	1.1959	33.50
CO	0.5420	15.18	0.3377	9.46
CO_2	0.2899	12.76	0.4942	21.75
Total	5.2515	99.99	5.2520	99.99

Hydrazine - UDMH - Oxygen

41.667	%	N_2H_4 - UDMH (50-50)
58.333	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3503 (^oK)

P_e	9.33	P_e	1.75	(psia)
T_e	2266	T_e	17.19	^oK
ϵ	10.90	ϵ	39.19	
I_{sp}	312.9	I_{sp}	350.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.4625	44.36	2.4433	44.02
H_2	0.2118	0.43	0.2429	0.49
H	0.0097	0.01	0.0004	00.00
OH	0.0154	0.26	0.0004	0.01
O_2	0.0026	0.08	0.0000	00.00
O	0.0004	0.01	0.0000	00.00
NO	0.0018	0.05	0.0000	00.00
N_2	0.9955	27.89	0.9967	27.92
CO	0.2267	6.35	0.1843	5.16
CO_2	0.4666	20.53	0.5090	22.40
	4.3929	99.97	4.3771	100.00

Total

Hydrazine - UDMH - Oxygen

43.478	%	N_2H_4 - UDMH (50-50)
56.522	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3487 (^oK)

P_e	9.33	P_e	1.75	(psia)
T_e	2101	T_e	1555	^oK
ϵ	10.39	ϵ	36.75	
I_{sp}	313.8	I_{sp}	350.0	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.4091	43.40	2.3483	42.31	
H_2	0.3899	0.79	0.4553	0.92	
H	0.0050	0.01	0.0000	00.00	
OH	0.0032	0.05	0.0000	00.00	
NO	0.0005	0.01	0.0000	00.00	
N_2	1.0400	29.14	1.0399	29.13	
CO	0.3273	9.17	0.2626	7.36	
CO_2	0.3963	17.44	0.4608	20.28	
	4.5713	100.01	4.5670	100.00	Total

Hydrazine - UDMH - Oxygen

45.455	%	N_2H_4 - UDMH (50-50)
54.545	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3452 (°K)

P_e	9.33	P_e	1.75 (psia)
T_e	1924	T_e	1404 °K
ϵ	9.90	ϵ	34.68
I_{sp}	313.1	I_{sp}	347.7 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.3082	41.58	2.2168	39.94	
H_2	0.6214	1.25	0.7138	1.44	
H	0.0019	00.00	0.0000	00.00	
OH	0.0005	0.01	0.0000	00.00	
N_2	1.0875	30.47	1.0872	30.46	
CO	0.4126	11.56	0.3204	8.97	
CO_2	0.3439	15.13	0.4359	19.18	
	4.7759	100.00	4.7741	99.99	Total

Hydrazine - UDMH - Oxygen

47.619	%	N_2H_4 - UDMH (50-50)
52.381	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3388 (^oK)

P_e	9.33	P_e	1.17 (psia)
T_e	1750	T_e	1165 ^oK
ϵ	9.46	ϵ	44.77
I_{sp}	311.1	I_{sp}	350.3 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.1718	39.13	2.0113	36.23
H_2	0.8983	1.81	1.0594	2.14
H	0.0005	00.00	0.0000	00.00
N_2	1.1389	31.91	1.1389	31.91
CO	0.4827	13.52	0.3221	9.02
CO_2	0.3096	13.63	0.4702	20.69
Total	5.0019	100.00	5.0019	99.99

Hydrazine - UDMH - Oxygen

50	%	N_2H_4 - UDMH (50-50)
50	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3285 (^oK)

P_e	9.33	P_e	1.17	(psia)
T_e	1582	T_e	1041	^oK
ϵ	9.10	ϵ	42.73	
I_{sp}	307.7	I_{sp}	345.2	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.0026	36.08	1.7978	32.39	
H_2	1.2216	2.46	1.4264	2.88	
N_2	1.1959	33.50	1.1959	33.50	
CO	0.5415	15.17	0.3366	9.43	
CO_2	0.2904	12.78	0.4953	21.80	
	5.2520	99.99	5.2520	100.00	Total

Ammonia - Oxygen

37.037	%	NH_3
62.963	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 2920 (^oK)

P_e	2.00	P_e	0.25	(psia)
T_e	1586	T_e	1048	^oK
ϵ	9.81	ϵ	45.92	
I_{sp}	282.6	I_{sp}	319.14	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.2607	58.74	3.2616	58.76	
OH	0.0019	0.03	0.0000	0.00	
O_2	0.3346	10.71	0.3364	10.76	
NO	0.0028	0.08	0.0000	0.00	
N_2	1.0858	30.42	1.0870	30.46	
	4.6858	99.98	4.6850	99.98	Total

Ammonia - Oxygen

40.00 %	NH_3
60.00 %	LOX
%	
%	

P_c 150 (psia)

T_c 2957 (^oK)

P_e	2.00	P_e	0.37 (psia)
T_e	1678	T_e	1217 ^oK
ϵ	10.07	ϵ	35.02
I_{sp}	291.6	I_{sp}	324.1 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.5204	63.42	3.5222	63.46	
H_2	0.0010	0.00	0.0000	0.00	
OH	0.0034	0.06	0.0005	0.01	
O_2	0.1121	3.59	0.1135	3.63	
NO	0.0024	0.07	0.0000	0.00	
N_2	1.1732	32.87	1.1742	32.90	
	4.8125	100.01	4.8104	100.00	Total

Ammonia - Oxygen

41.667	%	NH_3
58.333	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 2958 (^oK)

P_e	2.00	P_e	0.37 (psia)
T_e	1715	T_e	1245 ^oK
ϵ	10.20	ϵ	35.49
I_{sp}	295.5	I_{sp}	328.9 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.6439	65.65	3.6457	65.68	
H_2	0.0250	0.05	0.0240	0.05	
N_2	1.2230	34.27	1.2232	34.27	
OH	0.0010	0.02	0.0000	0.00	
O_2	0.0005	0.01	0.0000	0.00	
	4.8934	100.00	4.8929	100.00	Total

Ammonia - Oxygen

43.478	%	NH_3
56.522	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 2934 (^oK)

P_e	2.00	P_e	0.19	(psia)
T_e	1546	T_e	951	^oK
ϵ	9.57	ϵ	44.55	
I_{sp}	294.3	I_{sp}	331.4	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.5320	63.63	3.5323	63.64	
H_2	0.2966	0.60	0.2966	0.60	
N_2	1.2764	35.76	1.2763	35.76	
	5.1050	99.99	5.1052	100.00	Total

Ammonia - Oxygen

45.454	%	NH_3
54.545	%	LOX
	%	
	%	

P_c 150 (psia)

T_c 2864 (^oK)

P_e	2.00	P_e	0.25 (psia)
T_e	1394	T_e	895 ^oK
ϵ	9.15	ϵ	41.93
I_{sp}	290.6	I_{sp}	325.8 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.4092	61.42	3.4092	61.42	
H_2	0.5941	1.20	0.5940	1.20	
N_2	1.3344	37.39	1.3343	37.39	
	5.3377	100.01	5.3377	100.01	Total

Ammonia - Oxygen

37.037	%	NH_3
62.963	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 2968 (^oK)

P_e	4.00	P_e	0.50	(psia)
T_e	1580	T_e	1043	^oK
ϵ	9.71	ϵ	45.47	
I_{sp}	283.1	I_{sp}	319.4	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.2607	58.74	3.2618	58.76	
OH	0.0019	0.03	0.0000	0.00	
O_2	0.3346	10.71	0.3364	10.76	
NO	0.0028	0.08	0.0000	0.00	
N_2	1.0858	30.42	1.0870	30.46	
	4.6858	99.98	4.6850	99.98	Total

Ammonia - Oxygen

40.00 % NH_3
60.00 % LOX
%
%

P_c 300 (psia)
T_c 3011 (^oK)

P_e	4.00	P_e	0.75 (psia)
T_e	1670	T_e	1210 ^oK
ϵ	9.94	ϵ	34.59
I_{sp}	292.2	I_{sp}	324.5 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	3.5206	63.43	3.5222	63.46
H_2	0.0005	0.00	0.0000	0.00
OH	0.0024	0.04	0.0005	0.01
O_2	0.1121	3.59	0.1135	3.63
NO	0.0024	0.07	0.0000	0.00
N_2	1.1731	32.87	1.1742	32.90
Total	4.8111	100.00	4.8104	100.00

Ammonia - Oxygen

41.667	%	NH_3
58.333	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 3014 (^oK)

P_e	4.00	P_e	0.75	(psia)
T_e	1706	T_e	1237	^oK
ϵ	10.07	ϵ	35.03	
I_{sp}	296.3	I_{sp}	329.4	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.6445	65.66	3.6454	65.68	
H_2	0.0245	0.05	0.0240	0.05	
OH	0.0005	0.01	0.0000	0.00	
N_2	1.2233	34.28	1.2231	34.27	
	4.9128	100.00	4.8925	100.00	Total

Ammonia - Oxygen

43.478	%	NH_3
56.522	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 2985 (^oK)

P_e	4.00	P_e	0.50	(psia)
T_e	1540	T_e	1008	^oK
ϵ	9.48	ϵ	44.12	
I_{sp}	294.7	I_{sp}	331.7	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.5320	63.63	3.5323	63.64	
H_2	0.2966	0.60	0.2966	0.60	
N_2	1.2764	35.76	1.2764	35.76	
	5.1050	99.99	5.1053	100.00	Total

Ammonia - Oxygen

45.454	%	NH_3
54.545	%	LOX
	%	
	%	

P_c 300 (psia)

T_c 2905 (^oK)

P_e	4.00	P_e	0.50	(psia)
T_e	1391	T_e	893	^oK
ϵ	9.10	ϵ	41.68	
I_{sp}	290.8	I_{sp}	331.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.4089	61.41	3.4089	61.41	
H_2	0.5940	1.20	0.5940	1.20	
N_2	1.3343	37.39	1.3343	37.39	
	5.3372	100.00	5.3372	100.00	Total

Ammonia - Oxygen

37.037	%	NH_3
62.963	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3001 (^oK)

P_e	6.67	P_e	0.83	(psia)
T_e	1576	T_e	1040	^oK
ϵ	9.65	ϵ	45.19	
I_{sp}	283.4	I_{sp}	319.6	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.2607	58.74	3.2618	58.76	
OH	0.0019	0.03	0.0000	0.00	
O_2	0.3346	10.71	0.3364	10.76	
NO	0.0024	0.08	0.0000	0.00	
N_2	1.0858	30.42	1.0870	30.46	
	4.6858	99.98	4.6850	99.98	Total

Ammonia - Oxygen

40.00 % NH_3
60.00 % LOX
%
%

P_c 500 (psia)
T_c 3050 (^oK)

P_e	6.67	P_e	1.25 (psia)
T_e	1665	T_e	1206 ^oK
ϵ	9.86	ϵ	34.32
I_{sp}	292.7	I_{sp}	324.8 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	3.5213	63.44	3.5222	63.46
H_2	0.0005	0.00	0.0000	0.00
OH	0.0019	0.03	0.0005	0.01
O2	0.1121	3.59	0.1135	3.63
NO	0.0024	0.07	0.0000	0.00
N_2	1.1730	32.87	1.1742	32.90
Total	4.8112	100.00	4.8104	100.00

Ammonia - Oxygen

41.667	%	NH_3
58.333	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3053 (^oK)

P_e	6.67	1.25	(psia)
T_e	1699	1232	^oK
ϵ	9.98	34.73	
I_{sp}	296.8	329.7	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.6447	65.66	3.6454	65.68	
H2	0.0240	0.05	0.0240	0.05	
OH	0.0005	0.01	0.0000	0.00	
N2	1.2232	34.27	1.2231	34.27	
	4.8924	99.99	4.8925	100.00	Total

Ammonia - Oxygen

43.478	%	NH_3
56.522	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 3021 (^oK)

P_e	6.67	0.83	(psia)
T_e	1536	1005	^oK
ϵ	9.42	43.85	
I_{sp}	295.0	331.8	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.5323	63.64	3.5323	63.64	
H_2	0.2966	0.60	0.2966	0.60	
N_2	1.2764	35.76	1.2764	35.76	
	5.1053	100.00	5.1053	100.00	Total

Ammonia - Oxygen

45.454	%	NH_3
54.545	%	LOX
	%	
	%	

P_c 500 (psia)

T_c 2931 (^oK)

P_e	6.67	P_e	0.83	(psia)
T_e	1389	T_e	891	^oK
ϵ	9.07	ϵ	41.55	
I_{sp}	290.9	I_{sp}	326.0	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.4089	61.41	3.4089	61.41	
H_2	0.5940	1.20	0.5940	1.20	
N_2	1.3343	37.39	1.3343	37.39	
	5.3372	100.00	5.3372	100.00	Total

Ammonia - Oxygen

37.037	%	NH_3
62.963	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3021 (^oK)

P_e	9.33	1.17	(psia)
T_e	1573	1038	^oK
ϵ	9.61	45.02	
I_{sp}	283.6	319.7	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.2607	58.74	3.2618	58.76	
OH	0.0019	0.03	0.0000	0.00	
O_2	0.3346	10.71	0.3364	10.76	
NO	0.0028	0.08	0.0000	0.00	
N_2	1.0858	30.42	1.0870	30.46	
	4.6858	99.98	4.6850	99.98	Total

Ammonia - Oxygen

40.0	%	NH_3
60.0	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3074 (^oK)

P_e	9.33	P_e	1.75	(psia)
T_e	1662	T_e	1203	^oK
ϵ	9.82	ϵ	34.15	
I_{sp}	292.9	I_{sp}	325.0	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.5213	63.44	3.5222	63.46	
H_2	0.0005	0.00	0.0000	0.00	
OH	0.0019	0.03	0.0005	0.01	
O_2	0.1121	3.59	0.1135	3.63	
NO	0.0024	0.07	0.0000	0.00	
N_2	1.1730	32.87	1.0742	32.90	
	4.8112	100.00	4.8104	100.00	Total

Ammonia - Oxygen

41.667	%	NH_3
58.333	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3078 (^oK)

P_e	9.33	P_e	1.75	(psia)
T_e	1695	T_e	1229	^oK
ϵ	9.92	ϵ	34.54	
I_{sp}	297.1	I_{sp}	330.0	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.6447	65.66	3.6454	65.68	
H_2	0.0240	0.05	0.0240	0.05	
OH	0.0005	0.01	0.0000	0.00	
N_2	1.2232	34.27	1.2231	34.27	
	4.8924	99.99	4.8925	100.00	Total

Ammonia - Oxygen

43.478	%	NH_3
56.522	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 3043 (^oK)

P_e	9.33	P_e	1.17	(psia)
T_e	1534	T_e	1004	^oK
ϵ	9.38	ϵ	43.68	
I_{sp}	295.2	I_{sp}	331.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.5320	63.63	3.5323	63.64	
H_2	0.2966	0.60	0.2966	0.60	
N_2	1.2764	35.76	1.2764	35.76	
	5.1050	99.99	5.1053	100.00	Total

Ammonia - Oxygen

45.454	%	NH_3
54.545	%	LOX
	%	
	%	

P_c 700 (psia)

T_c 2946 (^oK)

P_e	9.33	P_e	1.17 (psia)
T_e	1388	T_e	891 ^oK
ϵ	9.05	ϵ	41.49
I_{sp}	291.0	I_{sp}	326.0 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	3.4089	61.41	3.4089	61.41	
H_2	0.5940	1.20	0.5940	1.20	
N_2	1.3343	37.39	1.3343	37.39	
	5.3372	100.00	5.3372	100.00	Total

Hydrazine-Nitrogen Tetroxide

43.478	%	N_2H_4
56.522	%	N_2O_4
	%	
	%	

P_c 150 (psia)

T_c 3087 (^oK)

P_e	2.00	P_e	0.25	(psia)
T_e	1665	T_e	1079	^oK
ϵ	9.64	ϵ	44.39	
I_{sp}	291.9	I_{sp}	328.7	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.4564	44.25	2.4569	44.26	
H_2	0.2562	0.52	0.2562	0.52	
N_2	1.9707	55.22	1.9707	55.22	
H	0.0005	0.00	0.0000	0.00	
OH	0.0005	0.01	0.0000	0.00	
	4.6843	100.00	4.6838	100.00	Total

Hydrazine-Nitrogen Tetroxide

45.455	%	N_2H_4
54.545	%	N_2O_4
	%	
	%	

P_c 150 (psia)

T_c 3066 (^oK)

P_e	2.00	P_e	0.25	(psia)
T_e	1558	T_e	996	^oK
ϵ	9.29	ϵ	42.36	
I_{sp}	291.4	I_{sp}	326.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.3710	42.72	2.3710	42.72	
H_2	0.4654	0.94	0.4654	0.94	
N_2	2.0108	56.34	2.0108	56.34	
	4.8472	99.98	4.8472	99.98	Total

Hydrazine-Nitrogen Tetroxide

47.62	%	N_2H_4
52.38	%	N_2O_4
	%	
	%	

P_c 150 (psia)

T_c 3024 (^oK)

P_e	2.00	P_e	0.25	(psia)
T_e	1454	T_e	917	^oK
ϵ	9.01	ϵ	40.62	
I_{sp}	290.1	I_{sp}	324.5	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.2766	41.02	2.2766	41.02	
H_2	0.6945	1.40	0.6945	1.40	
N_2	2.0549	57.58	2.0549	57.58	
	5.0260	100.00	5.0260	100.00	Total

Hydrazine-Nitrogen Tetroxide

50	%	N_2H_4
50	%	N_2O_4
	%	
	%	

P_c 150 (psia)

T_c 2956 (^oK)

P_e	1.50	P_e	0.25	(psia)
T_e	1269	T_e	840	^oK
ϵ	1075	ϵ	39.05	
I_{sp}	294.0	I_{sp}	321.4	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.1735	39.16	2.1735	39.16	
H_2	0.9470	1.91	0.9470	1.91	
N_2	2.1035	58.94	2.1035	58.94	
	5.2240	100.01	5.2240	100.01	Total

Hydrazine-Nitrogen Tetroxide

52.632	%	N_2H_4
47.368	%	N_2O_4
	%	
	%	

P_c 150 (psia)

T_c 2862 (^oK)

P_e	1.50	P_e	0.25	(psia)
T_e	1169	T_e	764	^oK
ϵ	10.46	ϵ	37.60	
I_{sp}	291.1	I_{sp}	317.6	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.0590	37.09	2.0589	37.09	
H_2	1.2254	2.47	1.2253	2.47	
N_2	2.1570	60.44	2.1568	60.43	
	5.4414	100.00	5.4410	100.00	Total

Hydrazine-Nitrogen Tetroxide

41.67	%	N_2H_4
58.33	%	N_2O_4
	%	
	%	

P_c 300 (psia)

T_c 3157 (^oK)

P_e	4.00	P_e	0.75	(psia)
T_e	1767	T_e	1263	^oK
ϵ	9.93	ϵ	34.09	
I_{sp}	292.2	I_{sp}	324.3	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.5348	45.67	2.5355	45.68	
H_2	0.0648	0.13	0.0638	0.13	
H	0.0004	0.00	0.0000	0.00	
OH	0.0004	0.01	0.0000	0.00	
N_2	1.9340	54.19	1.9338	54.19	
	4.5344	100.00	4.5331	100.00	Total

Hydrazine-Nitrogen Tetroxide

45.455	%	N_2H_4
54.545	%	N_2O_4
	%	
	%	

P_c 300 (psia)

T_c 3125 (^oK)

P_e	4.00	P_e	0.50	(psia)
T_e	1551	T_e	991	^oK
ϵ	9.19	ϵ	41.91	
I_{sp}	291.9	I_{sp}	327.2	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.3710	42.72	2.3710	42.72	
H_2	0.4654	0.94	0.4654	0.94	
N_2	2.0108	56.34	2.0108	56.34	
	4.8472	99.98	4.8472	99.98	Total

Hydrazine-Nitrogen Tetroxide

47.619	%	N_2H_4
52.381	%	N_2O_4
	%	
	%	

P_c 300 (psia)

T_c 3074 (^oK)

P_e	3.00	P_e	0.50	(psia)
T_e	1364	T_e	914	^oK
ϵ	10.98	ϵ	40.30	
I_{sp}	296.4	I_{sp}	324.7	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.2766	41.02	2.2771	41.02	
H_2	0.6947	1.40	0.6947	1.40	
N_2	2.0549	57.58	2.0549	57.58	
	5.0262	100.00	5.0261	100.00	Total

Hydrazine-Nitrogen Tetroxide

50	%	N_2H_4
50	%	N_2O_4
	%	
	%	

P_c 300 (psia)

T_c 2997 (^oK)

P_e	3.00	P_e	0.50	(psia)
T_e	1266	T_e	838	^oK
ϵ	10.69	ϵ	38.82	
I_{sp}	294.2	I_{sp}	321.5	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.1735	39.16	2.1735	39.16	
H_2	0.9470	1.91	0.9465	1.91	
N_2	2.1035	58.94	2.1035	58.95	
	5.2240	100.01	5.2235	100.01	Total

Hydrazine-Nitrogen Tetroxide

56.52	%	N_2O_4
43.48	%	N_2H_4
	%	
	%	

P_c 300 (psia)

T_c 3151 (^oK)

P_e	4.00	P_e	0.50	(psia)
T_e	1655	T_e	1072	^oK
ϵ	9.51	ϵ	43.79	
I_{sp}	292.6	I_{sp}	329.1	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.4564	44.25	2.4569	44.26
H_2	0.2562	0.52	0.2562	0.52
N_2	1.9707	55.22	1.9707	55.22
OH	0.0005	0.01	0.0000	0.00
Total	4.6838	100.00	4.6838	100.00

Hydrazine-Nitrogen Tetroxide

40	%	N_2H_4
60	%	N_2O_4
	%	
	%	

P_c 500 (psia)

T_c 3194 (^oK)

P_e	6.67	P_e	0.83	(psia)
T_e	1758	T_e	1156	^oK
ϵ	9.86	ϵ	45.93	
I_{sp}	289.6	I_{sp}	327.0	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.4936	44.93	2.4960	44.98	
H_2	0.0013	0.00	0.0000	0.00	
OH	0.0027	0.05	0.0000	0.00	
O_2	0.0543	1.74	0.0561	1.80	
NO	0.0031	0.09	0.0000	0.00	
N_2	1.8986	53.20	1.8998	53.23	
	4.4536	100.01	4.4520	100.01	Total

Hydrazine-Nitrogen Tetroxide

41.667	%	N_2H_4
58.333	%	N_2O_4
	%	
	%	

P_c 500 (psia)

T_c 3204 (^oK)

P_e	6.67	P_e	0.83	(psia)
T_e	1759	T_e	1153	^oK
ϵ	9.82	ϵ	45.63	
I_{sp}	292.8	I_{sp}	330.5	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.5353	45.69	2.5355	45.69
H_2	0.0648	0.13	0.0644	0.13
OH	0.0004	0.01	0.0000	0.00
N_2	1.9340	54.19	1.9338	54.19
Total	4.5346	100.02	4.5337	100.01

Hydrazine-Nitrogen Tetroxide

43.478 %	N_2H_4
56.522 %	N_2O_4
%	
%	

P_c 500 (psia)

T_c 3196 (^oK)

P_e	6.67	P_e	0.83	(psia)
T_e	1649	T_e	1067	^oK
ϵ	9.42	ϵ	43.41	
I_{sp}	293.0	I_{sp}	329.3	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.4565	44.27	2.4567	44.27
H_2	0.2562	0.52	0.2562	0.52
OH	0.0005	0.01	0.0000	0.00
N_2	1.9707	55.22	1.9705	55.21
Total	4.6839	100.02	4.6834	100.00

Hydrazine-Nitrogen Tetroxide

45.455	%	N_2H_4
54.545	%	N_2O_4
	%	
	%	

P_c 500 (psia)

T_c 3166 (^oK)

P_e	6.67	0.83	(psia)
T_e	1547	988	^oK
ϵ	9.13	41.62	
I_{sp}	292.2	327.4	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.3710	42.73	2.3710	42.73	
H_2	0.4654	0.94	0.4654	0.94	
N_2	2.0108	56.34	2.0108	56.34	
	4.8472	100.01	4.8472	100.01	Total

Hydrazine-Nitrogen Tetroxide

47.619	%	N_2H_4
52.381	%	N_2O_4
	%	
	%	

P_c 500 (psia)

T_c 3109 (^oK)

P_e	5.00	P_e	0.83	(psia)
T_e	1361	T_e	912	^oK
ϵ	10.93	ϵ	40.11	
I_{sp}	296.6	I_{sp}	324.8	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.2766	41.02	2.2771	41.03	
H_2	0.6947	1.40	0.6947	1.40	
N_2	2.0549	57.58	2.0549	57.58	
	5.0262	100.00	5.0267	100.01	Total

Hydrazine-Nitrogen Tetroxide

40	%	N_2H_4
60	%	N_2O_4
	%	
	%	

P_c 700 (psia)

T_c 3224 (^oK)

P_e	9.33	1.17	(psia)
T_e	1753	1153	^oK
ϵ	9.79	45.62	
I_{sp}	289.9	327.2	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	2.4940	44.94	2.4960	44.98
H_2	0.0009	0.00	0.0000	0.00
OH	0.0022	0.04	0.0000	0.00
O_2	0.0543	1.74	0.0561	1.80
NO	0.0031	0.09	0.0000	0.00
N_2	1.8986	53.20	1.8998	53.23
Total	4.4531	100.01	4.4519	100.01

Hydrazine-Nitrogen Tetroxide

41.667	%	N_2H_4
58.333	%	N_2O_4
	%	
	%	

P_c 700 (psia)

T_c 3234 (^oK)

P_e	9.33	P_e	1.17	(psia)
T_e	1754	T_e	1150	^oK
ϵ	9.76	ϵ	45.34	
I_{sp}	293.2	I_{sp}	330.7	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.5353	45.69	2.5355	45.69	
H_2	0.0648	0.13	0.0644	0.13	
OH	0.0004	0.01	0.0000	00.00	
N_2	1.9340	54.19	1.9338	54.19	
	4.5345	100.02	4.5337	100.01	Total

Hydrazine-Nitrogen Tetroxide

43.478	%	N_2H_4
56.522	%	N_2O_4
	%	
	%	

P_c 700 (psia)

T_c 3225 (^oK)

P_e	9.33	P_e	1.17 (psia)
T_e	1645	T_e	1065 ^oK
ϵ	9.37	ϵ	43.18
I_{sp}	293.3	I_{sp}	329.5 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.4569	44.27	2.4567	44.27	
H_2	0.2562	0.52	0.2562	0.52	
OH	0.0005	0.01	0.0000	00.00	
N_2	1.9707	55.22	1.9705	55.21	
	4.6843	100.02	4.6834	100.00	Total

Hydrazine-Nitrogen Tetroxide

45.455	%	N_2H_4
54.545	%	N_2O_4
	%	
	%	

P_c 700 (psia)

T_c 3192 (^oK)

P_e	9.33	P_e	1.17	(psia)
T_e	1544	T_e	986	^oK
ϵ	9.09	ϵ	41.46	
I_{sp}	292.4	I_{sp}	327.5	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.3710	42.73	2.3710	42.73	
H_2	0.4654	0.94	0.4654	0.94	
N_2	2.0108	56.34	2.0108	56.34	
	4.8472	100.01	4.8472	100.01	Total

Hydrazine-Nitrogen Tetroxide

47.381 % N_2H_4
52.381 % N_2O_4
%
%

P_c 700 (psia)
T_c 3130 (^oK)

P_e	7.00	P_e	1.17	(psia)
T_e	1359	T_e	911	^oK
ϵ	10.89	ϵ	40.00	
I_{sp}	296.7	I_{sp}	324.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	2.2766	41.02	2.2771	41.03	
H_2	0.6947	1.40	0.6947	1.40	
N_2	2.0549	57.58	2.0549	57.58	
	5.0262	100.00	5.0267	100.01	Total

UDMH-Nitrogen Tetroxide

27.778 % UDMH
72.222 % N_2O_4
%
%

P_c 150 (psia)
T_c 3211 (^oK)

P_e	2.00	0.37	(psia)
T_e	1985	1464	^oK
ϵ	10.54	37.09	
I_{sp}	284.7	317.8	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.6355	29.46	1.5742	28.36
H_2	0.2100	0.42	0.2742	0.55
H	0.0036	00.00	0.0000	00.00
OH	0.0024	0.04	0.0000	00.00
NO	0.0004	0.01	0.0000	00.00
N_2	1.2468	34.94	1.2470	34.94
CO	0.3476	9.74	0.2838	7.95
CO_2	0.5765	25.37	0.6408	28.20
Total	4.0228	99.98	4.0200	100.00

UDMH-Nitrogen Tetroxide

29.412	%	UDMH
70.588	%	N_2O_4
	%	
	%	

P_c 150 (psia)

T_c 3195 (^oK)

P_e	2.00	P_e	0.37	(psia)
T_e	1821	T_e	1328	^oK
ϵ	9.98	ϵ	34.94	
I_{sp}	284.7	I_{sp}	316.3	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.5864	28.58	1.4858	26.75	
H_2	0.3699	0.74	0.4712	0.95	
H	0.0012	00.00	0.0000	00.00	
OH	0.0004	0.01	0.0000	00.00	
N_2	1.2564	35.20	1.2565	35.21	
CO	0.4760	13.33	0.3752	10.51	
CO_2	0.5028	22.13	0.6037	26.57	
	4.1931	99.99	4.1924	99.99	Total

UDMH-Nitrogen Tetroxide

31.250	%	UDMH
68.750	%	N_2O_4
	%	
	%	

P_c 150 (psia)

T_c 3160 (^oK)

P_e	2.00	P_e	0.25	(psia)
T_e	1660	T_e	1109	^oK
ϵ	9.50	ϵ	45.13	
I_{sp}	283.4	I_{sp}	319.2	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.4990	27.00	1.3133	23.66	
H_2	0.5804	1.17	0.7663	1.54	
N_2	1.2669	35.50	1.2668	35.50	
CO	0.5905	16.54	0.4049	11.34	
CO_2	0.4496	19.79	0.6352	27.96	
	4.3864	100.00	4.3865	100.00	Total

UDMH-Nitrogen Tetroxide

33.333 % UDMH
66.667 % N_2O_4

P_c 150 (psia)
T_c 3088 (^oK)

P_e	2.00	P_e	0.25 (psia)
T_e	1501	T_e	997 ^oK
ϵ	9.10	ϵ	43.11
I_{sp}	280.8	I_{sp}	315.0 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.3728	24.73	1.1319	20.39
H_2	0.8453	1.70	1.0867	2.19
N_2	1.2793	35.84	1.2793	35.84
CO	0.6933	19.42	0.4524	12.67
CO_2	0.4160	18.31	0.6569	28.91
Total	4.6067	100.00	4.6072	100.00

UDMH-Nitrogen Tetroxide

35.714	%	UDMH
64.286	%	N_2O_4
	%	
	%	

P_c 150 (psia)

T_c 2966 (^oK)

P_e	1.50	P_e	0.25 (psia)
T_e	1268	T_e	890 ^oK
ϵ	10.82	ϵ	41.57
I_{sp}	282.3	I_{sp}	309.4 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.1742	21.15	0.9056	16.32
H_2	1.2029	2.42	1.4715	2.97
N_2	1.2928	36.22	1.2928	36.22
CO	0.7564	21.19	0.4878	13.66
CO_2	0.4319	19.01	0.7005	30.83
Total	4.8582	99.99	4.8582	100.00

UDMH-Nitrogen Tetroxide

27.778	%	UDMH
72.222	%	N_2O_4
	%	
	%	

P_c 300 (psia)

T_c 3288 (^oK)

P_e	4.00	P_e	0.75 (psia)
T_e	1971	T_e	1450 ^oK
ϵ	10.35	ϵ	36.41
I_{sp}	285.8	I_{sp}	318.6 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.6353	29.46	1.5718	28.32
H_2	0.2111	0.42	0.2766	0.56
H	0.0024	00.00	0.0000	00.00
OH	0.0016	0.04	0.0000	00.00
N_2	1.2468	34.94	1.2470	34.94
CO	0.3463	9.70	0.2814	7.88
CO_2	0.5779	25.43	0.6432	28.31
Total	4.0214	99.99	4.0200	100.01

UDMH-Nitrogen Tetroxide

29.412	%	UDMH
70.588	%	N_2O_4
	%	
	%	

P_c 300 (psia)

T_c 3271 (^oK)

P_e	4.00	P_e	0.75 (psia)
T_e	1810	T_e	1319 ^oK
ϵ	9.83	ϵ	34.41
I_{sp}	285.5	I_{sp}	316.8 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.5850	28.55	1.4833	26.72	
H_2	0.3715	0.75	0.4742	0.96	
H	0.0008	00.00	0.0000	00.00	
O_2	0.0004	0.01	0.0000	00.00	
N_2	1.2563	35.20	1.2565	35.21	
CO	0.4742	13.28	0.3723	10.43	
CO_2	0.5044	22.20	0.6067	26.70	
	4.1926	99.98	4.1930	100.02	Total

<u>UDMH-Nitrogen Tetroxide</u>

31.250	%	UDMH
68.750	%	N_2O_4
	%	
	%	

P_c 300 (psia)

T_c 3226 (^oK)

P_e	4.00	P_e	0.50 (psia)
T_e	1652	T_e	1104 ^oK
ϵ	9.39	ϵ	44.61
I_{sp}	284.0	I_{sp}	319.5 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.4972	26.97	1.3102	23.60	
H_2	0.5821	1.17	0.7694	1.62	
N_2	1.2669	35.50	1.2668	35.50	
CO	0.5887	16.49	0.4018	11.25	
CO_2	0.4510	19.85	0.6382	28.09	
	4.3859	99.98	4.3864	100.06	Total

UDMH-Nitrogen Tetroxide

33.333 % UDMH
66.667 % N_2O_4
%
%

P_c 300 (psia)
T_c 3141 (^oK)

P_e	4.00	P_e	0.50 (psia)
T_e	1497	T_e	994 ^oK
ϵ	9.03	ϵ	42.79
I_{sp}	281.1	I_{sp}	315.2 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.3714	24.71	1.1296	20.35
H_2	0.8467	1.71	1.0890	2.20
N_2	1.2793	35.84	1.2793	35.84
CO	0.6919	19.38	0.4501	12.61
CO_2	0.4174	18.37	0.6592	29.01
Total	4.6067	100.01	4.6072	100.01

UDMH-Nitrogen Tetroxide

35.714 % UDMH
64.286 % N_2O_4
%
%

P_c 300 (psia)
T_c 3004 (^oK)

P_e	3.00	P_e	0.50 (psia)
T_e	1266	T_e	888 ^oK
ϵ	10.78	ϵ	41.41
I_{sp}	282.5	I_{sp}	309.5 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.1728	21.13	0.9040	16.29	
H_2	1.2039	2.43	1.4729	2.97	
N_2	1.2928	36.22	1.2927	36.22	
CO	0.7554	21.16	0.4863	13.62	
CO_2	0.4329	19.05	0.7020	30.90	
	4.8578	99.99	4.8581	100.00	Total

UDMH-Nitrogen Tetroxide

27.778	%	UDMH
72.222	%	N_2O_4
	%	
	%	

P_c 500 (psia)

T_c 3345 (^oK)

P_e	6.67	P_e	1.25 (psia)
T_e	1962	T_e	1442 ^oK
ϵ	10.21	ϵ	35.95
I_{sp}	286.6	I_{sp}	319.1 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.6351	29.46	1.5702	28.29
H_2	0.2119	0.42	0.2782	0.56
H	0.0016	00.00	0.0000	00.00
OH	0.0012	0.03	0.0000	00.00
N_2	1.2470	34.94	1.2470	34.94
CO	0.3458	9.68	0.2798	7.84
CO_2	0.5787	25.47	0.6448	28.38
Total	4.0213	100.00	4.0200	100.01

UDMH-Nitrogen Tetroxide

29.412 % UDMH
70.588 % N_2O_4
%
%

P_c 500 (psia)
T_c 3324 (^oK)

P_e	6.67	P_e	1.25 (psia)
T_e	1802	T_e	1313 ^oK
ϵ	9.73	ϵ	34.08
I_{sp}	286.1	I_{sp}	317.2 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.5841	28.54	1.4812	26.68
H_2	0.3727	0.75	0.4759	0.96
H	0.0008	00.00	0.0000	00.00
N_2	1.2562	35.20	1.2565	35.21
CO	0.4734	13.26	0.3706	10.38
CO_2	0.5052	22.23	0.6083	26.77
Total	4.1924	99.98	4.1925	100.00

UDMH-Nitrogen Tetroxide

31.250	%	UDMH
68.750	%	N_2O_4
	%	
	%	

P_c 500 (psia)

T_c 3273 (^oK)

P_e	6.67	P_e	0.83 (psia)
T_e	1647	T_e	1101 ^oK
ϵ	9.32	ϵ	44.31
I_{sp}	284.3	I_{sp}	319.7 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.4964	26.96	1.3085	23.57
H_2	0.5830	1.17	0.7711	1.55
N_2	1.2669	35.50	1.2668	35.50
CO	0.5878	16.46	0.4000	11.20
CO_2	0.4523	19.90	0.6400	28.16
Total	4.3864	99.99	4.3864	99.98

UDMH-Nitrogen Tetroxide

33.333	%	UDMH
66.667	%	N_2O_4
	%	
	%	

P_c 500 (psia)

T_c 3177 (^oK)

P_e	6.67	P_e	0.83	(psia)
T_e	1494	T_e	992	^oK
ϵ	8.99	ϵ	42.60	
I_{sp}	281.3	I_{sp}	315.3	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.3705	24.69	1.1277	20.32	
H_2	0.8476	1.71	1.0904	2.20	
N_2	1.2793	35.84	1.2793	35.84	
CO	0.6910	19.35	0.4482	12.55	
CO_2	0.4178	18.39	0.6606	29.07	
	4.6062	99.98	4.6062	99.98	Total

UDMH-Nitrogen Tetroxide

35.714	%	UDMH
64.286	%	N_2O_4
	%	
	%	

P_c 500 (psia)

T_c 3028 (^oK)

P_e	5.00	P_e	0.83	(psia)
T_e	1264	T_e	887	^oK
ϵ	10.75	ϵ	41.32	
I_{sp}	282.6	I_{sp}	309.6	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.1723	21.12	0.9030	16.27	
H_2	1.2043	2.43	1.4728	2.97	
N_2	1.2928	36.22	1.2926	36.22	
CO	0.7550	21.15	0.4853	13.59	
CO_2	0.4338	19.09	0.7029	30.93	
	4.8582	100.01	4.8566	99.98	Total

UDMH-Nitrogen Tetroxide

27.778 % UDMH
72.222 % N_2O_4
%
%

P_c 700 (psia)
T_c 3382 (°K)

P_e 9.33		P_e 1.75	(psia)
T_e 1956		T_e 1437	°K
ϵ 10.14		ϵ 35.68	
I_{sp} 287.1		I_{sp} 319.4	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.6350	29.46	1.5698	28.28	
H_2	0.2127	0.43	0.2795	0.56	
H	0.0012	00.00	0.0000	00.00	
OH	0.0008	0.01	0.0000	00.00	
N_2	1.2469	34.94	1.2473	34.95	
CO	0.3450	9.66	0.2787	7.81	
CO_2	0.5790	25.48	0.6458	28.42	
	4.0206	99.98	4.0211	100.02	Total

UDMH-Nitrogen Tetroxide

29.412 % UDMH
70.588 % N_2O_4
%
%

P_c 700 (psia)
T_c 3359 (^oK)

P_e	9.33	P_e	1.17 (psia)
T_e	1798	T_e	1211 ^oK
ϵ	9.66	ϵ	46.15
I_{sp}	286.4	I_{sp}	323.1 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.5836	28.53	1.4464	26.06
H_2	0.3736	0.75	0.5106	1.03
H	0.0004	00.00	0.0000	00.00
N_2	1.2566	35.21	1.2565	35.21
CO	0.4730	13.25	0.3358	9.40
CO_2	0.5061	22.27	0.6431	28.30
Total	4.1933	100.01	4.1924	100.00

UDMH-Nitrogen Tetroxide

31.250	%	UDMH
68.750	%	N_2O_4
	%	
	%	

P_c 700 (psia)

T_c 3302 (^oK)

P_e	9.33	P_e	1.17	(psia)
T_e	1644	T_e	1099	^oK
ϵ	9.28	ϵ	44.10	
I_{sp}	284.5	I_{sp}	319.8	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.4960	26.95	1.3072	23.55	
H_2	0.5838	1.18	0.7720	1.56	
N_2	1.2669	16.44	1.2668	35.50	
CO	0.5869	35.50	0.3987	11.17	
CO_2	0.4527	19.92	0.6413	28.22	
	4.3863	99.99	4.3860	100.00	Total

UDMH-Nitrogen Tetroxide

33.333	%	UDMH
66.667	%	N_2O_4
	%	
	%	

P_c 700 (psia)

T_c 3199 (^oK)

P_e	9.33	P_e	1.17	(psia)
T_e	1492	T_e	991	^oK
ϵ	8.96	ϵ	42.49	
I_{sp}	281.4	I_{sp}	315.4	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.3700	24.68	1.1268	20.30
H_2	0.8481	1.71	1.0913	2.20
N_2	1.2793	35.84	1.2793	35.84
CO	0.6905	19.34	0.4473	12.53
CO_2	0.4183	18.41	0.6615	29.11
Total	4.6062	99.98	4.6062	99.98

UDMH-Nitrogen Tetroxide

35.714	%	UDMH
64.286	%	N_2O_4
	%	
	%	

P_c 700 (psia)

T_c 3042 (^oK)

P_e	7.00	P_e	1.17 (psia)
T_e	1263	T_e	887 ^oK
ϵ	10.73	ϵ	41.27
I_{sp}	282.7	I_{sp}	309.7 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.1718	21.11	0.9029	16.27
H_2	1.2048	2.43	1.4727	2.97
N_2	1.2928	36.22	1.2930	36.23
CO	0.7545	21.13	0.4847	13.58
CO_2	0.4343	19.11	0.7033	30.95
Total	4.8582	100.00	4.8566	100.00

Hydrazine-UDMH-Nitrogen Tetroxide

30.303	%	UDMH-N_2H_4(50/50)
69.697	%	N_2O_4
	%	
	%	

P_c 150 (psia)

T_c 3150 (^oK)

P_e	2.00	P_e	0.37	(psia)
T_e	2054	T_e	1580	^oK
ϵ	10.99	ϵ	39.87	
I_{sp}	283.4	I_{sp}	318.3	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.9249	34.68	1.9524	35.17	
H_2	0.0204	0.04	0.0008	00.00	
H	0.0016	00.00	0.0000	00.00	
OH	0.0160	0.27	0.0012	0.02	
O_2	0.0492	1.57	0.0334	1.07	
O_2	0.0012	0.02	0.0000	00.00	
NO	0.0060	0.18	0.0012	0.03	
N_2	1.4794	41.45	1.4818	41.52	
CO	0.0248	0.69	0.0004	0.01	
CO_2	0.4791	21.08	0.5036	22.16	
	4.0026	99.98	3.9748	99.98	Total

Hydrazine-UDMH-Nitrogen Tetroxide

31.250 % UDMH-N_2H_4(50/50)
68.750 % N_2O_4
%
%

P_c 150 (psia)
T_c 3158 (^oK)

P_e	2.00	P_e	0.37 (psia)
T_e	2059	T_e	1562 ^oK
ϵ	10.98	ϵ	39.40
I_{sp}	285.5	I_{sp}	320.4 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.9632	35.37	1.9766	35.61
H_2	0.0446	0.09	0.0383	0.08
H	0.0028	00.00	0.0000	00.00
OH	0.0113	0.19	0.0000	00.00
O_2	0.0113	0.36	0.0000	00.00
O	0.0008	0.01	0.0000	00.00
N_2	1.4929	41.83	1.4946	41.88
CO	0.0526	1.47	0.0282	0.79
CO_2	0.4674	20.57	0.4916	21.64
NO	0.0028	0.08		
Total	4.0497	99.97	4.0293	100.00

Hydrazine-UDMH-Nitrogen Tetroxide

33.333	%	UDMH-N_2H_4(50/50)
66.667	%	N_2O_4
	%	
	%	

P_c 150 (psia)

T_c 3164 (^oK)

P_e	2.00	P_e	0.37 (psia)
T_e	1900	T_e	1386 ^oK
ϵ	1035	ϵ	36.11
I_{sp}	287.8	I_{sp}	320.6 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.9545	35.21	1.9092	34.40	
H_2	0.1932	0.39	0.2400	0.48	
H	0.0021	00.00	0.0000	00.00	
OH	0.0013	0.02	0.0000		
N_2	1.5220	42.65	1.5217	42.64	
CO	0.1674	4.69	0.1204	3.37	
CO_2	0.3872	17.04	0.4340	19.10	
	4.2277	100.00	4.2253	99.99	Total

Hydrazine-UDMH-Nitrogen Tetroxide

35.714	%	UDMH-N_2H_4(50/50)
64.286	%	N_2O_4
	%	
	%	

P_c 150 (psia)

T_c 3145 (^oK)

P_e	2.00	P_e	0.25 (psia)
T_e	1712	T_e	1136 ^oK
ϵ	9.70	ϵ	45.70
I_{sp}	287.6	I_{sp}	324.4 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.8745	33.77	1.7646	31.79	
H_2	0.4281	0.86	0.5385	1.08	
N_2	1.5527	43.51	1.5532	43.52	
CO	0.2684	7.52	0.1584	4.44	
CO_2	0.3258	14.34	0.4357	19.17	
	4.4495	100.00	4.4504	100.00	Total

Hydrazine-UDMH-Nitrogen Tetroxide

40.00	%	UDMH-N_2H_4(50/50)
60.00	%	N_2O_4
	%	
	%	

P_c 150 (psia)

T_c 3033 (^oK)

P_e	2.00	P_e	0.25 (psia)
T_e	1441	T_e	941 ^oK
ϵ	8.99	ϵ	41.90
I_{sp}	283.9	I_{sp}	317.9 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.6599	29.90	1.4731	26.54
H_2	0.9193	1.85	1.1056	2.23
N_2	1.6090	45.08	1.6090	45.08
CO	0.3829	10.72	0.1961	5.49
CO_2	0.2825	12.44	0.4693	20.66
Total	4.8536	99.99	4.8531	100.00

Hydrazine-UDMH-Nitrogen Tetroxide

30.303	%	UDMH-N_2H_4(50/50)
69.697	%	N_2O_4
	%	
	%	

P_c 300 (psia)

T_c 3222 (^oK)

P_e	4.00	P_e	0.75 (psia)
T_e	2055	T_e	1564 ^oK
ϵ	10.85	ϵ	39.07
I_{sp}	284.7	I_{sp}	319.2 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.9316	34.80	1.9524	35.17
H_2	0.0152	0.03	0.0008	00.00
H	0.0012	00.00	0.0000	00.00
OH	0.0132	0.22	0.0012	0.02
O_2	0.0444	1.42	0.0334	1.07
O	0.0008	0.01	0.0000	00.00
NO	0.0060	0.18	0.0012	0.03
N_2	1.4792	41.45	1.4818	41.52
CO	0.0188	0.53	0.0004	0.01
CO_2	0.4855	21.37	0.5036	22.16
	3.9959	100.01	3.9748	99.98 Total

Hydrazine-UDMH-Nitrogen Tetroxide

31.250	%	UDMH-N_2H_4(50/50)
68.750	%	N_2O_4
	%	
	%	

P_c 300 (psia)

T_c 3232 (°K)

P_e	4.00	P_e	0.75	(psia)
T_e	2059	T_e	1546	°K
ϵ	10.84	ϵ	38.59	
I_{sp}	286.8	I_{sp}	321.4	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.9699	35.49	1.9766	35.61
H_2	0.0396	0.08	0.0383	0.08
H	0.0020	00.00	0.0000	00.00
OH	0.0085	0.14	0.0000	00.00
O_2	0.0073	0.23	0.0000	00.00
O	0.0004	00.00	0.0000	00.00
N_2	1.4932	41.84	1.4946	41.88
CO	0.0473	1.32	0.0282	0.79
CO_2	0.4727	20.80	0.4916	21.64
NO	0.0024	0.07	0.0000	00.00
Total	4.0409	99.97	4.0293	100.00

Hydrazine-UDMH-Nitrogen Tetroxide

33.333	%	UDMH-N_2H_4(50/50)
66.667	%	N_2O_4
	%	
	%	

P_c 300 (psia)

T_c 3237 (^oK)

P_e	4.00	P_e	0.75	(psia)
T_e	1887	T_e	1375	^oK
ϵ	10.17	ϵ	35.50	
I_{sp}	288.8	I_{sp}	321.2	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.9541	35.20	1.9075	34.36	
H_2	0.1940	0.39	0.2417	0.49	
H	0.0013	00.00	0.0000	00.00	
OH	0.0008	0.01	0.0000	00.00	
N_2	1.5217	42.64	1.5217	42.64	
CO	0.1665	4.66	0.1192	3.34	
CO_2	0.3880	17.08	0.4357	19.17	
	4.2264	99.98	4.2258	100.00	Total

Hydrazine-UDMH-Nitrogen Tetroxide

35.714	%	UDMH-N_2H_4(50/50)
64.286	%	N_2O_4
	%	
	%	

P_c 300 (psia)

T_c 3213 (^oK)

P_e	4.00	0.50	(psia)
T_e	1702	1130	^oK
ϵ	9.57	45.10	
I_{sp}	288.3	324.8	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.8732	33.75	1.7624	31.75
H_2	0.4295	0.86	0.5403	1.09
N_2	1.5527	43.51	1.5532	43.52
CO	0.2675	7.52	0.1566	4.39
CO_2	0.3271	14.40	0.4379	19.27
Total	4.4500	100.04	4.4504	100.02

Hydrazine-UDMH-Nitrogen Tetroxide

40.00	%	UDMH-N_2H_4(50/50)
60.00	%	N_2O_4
	%	
	%	

P_c 300 (psia)

T_c 3081 (^oK)

P_e	3.00	P_e	0.50	(psia)
T_e	1355	T_e	938	^oK
ϵ	10.99	ϵ	41.61	
I_{sp}	290.0	I_{sp}	318.1	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.6391	29.53	1.4716	26.51
H_2	0.9401	1.90	1.1071	2.23
N_2	1.6090	45.08	1.6090	45.08
CO	0.3621	10.14	0.1946	5.45
CO_2	0.3038	13.37	0.4708	20.72
Total	4.8541	100.02	4.8531	99.99

Hydrazine-UDMH-Nitrogen Tetroxide

30.303 % UDMH-N_2O_4(50/50)
69.697 % N_2O_4
%
%

P_c 500 (psia)
T_c 3275 (^oK)

P_e	6.67	P_e	1.25	(psia)
T_e	2054	T_e	1552	^oK
ϵ	10.75	ϵ	38.52	
I_{sp}	285.6	I_{sp}	319.9	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.9359	34.88	1.9524	35.17
H_2	0.0120	0.02	0.0008	00.00
H	0.0008	00.00	0.0000	00.00
OH	0.0112	0.19	0.0012	0.02
O_2	0.0415	1.33	0.0334	1.07
O	0.0008	0.01	0.0000	00.00
NO	0.0056	0.17	0.0012	0.03
N_2	1.4796	41.46	1.4818	41.52
CO	0.0152	0.42	0.0004	0.01
CO_2	0.4890	21.52	0.5036	22.16
Total	3.9916	100.00	3.9748	99.98

Hydrazine-UDMH-Nitrogen Tetroxide

31.250 % UDMH-N_2H_4(50/50)
68.750 % N_2O_4

P_c 500 (psia)
T_c 3285 (^oK)

P_e	6.67	P_e	1.25	(psia)
T_e	2056	T_e	1534	^oK
ϵ	1072	ϵ	3804	
I_{sp}	287.7	I_{sp}	322.1	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	1.9738	35.56	1.9766	35.61
H_2	0.0368	0.07	0.0383	0.08
H	0.0012	00.00	0.0000	00.00
OH	0.0069	0.12	0.0000	00.00
O_2	0.0048	0.15	0.0000	00.00
O	0.0004	00.00	0.0000	00.00
N_2	1.4935	41.85	1.4946	41.88
CO	0.0440	1.23	0.0282	0.79
CO_2	0.4759	20.94	0.4916	21.64
NO	0.0020	0.06	0.0000	00.00
Total	4.0393	99.98	4.0293	100.00

Hydrazine-UDMH-Nitrogen Tetroxide

33.333	%	UDMH-N_2H_4(50/50)
66.667	%	N_2O_4
	%	
	%	

P_c 500 (psia)

T_c 3290 (°K)

P_e	6.67	P_e	1.25	(psia)
T_e	1878	T_e	1367	°K
ϵ	10.05	ϵ	35.09	
I_{sp}	289.4	I_{sp}	321.7	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.9540	35.20	1.9075	34.36	
H_2	0.1948	0.39	0.2417	0.49	
H	0.0008	00.00	0.0000	00.00	
OH	0.0004	00.00	0.0000	00.00	
N_2	1.5220	42.67	1.5217	42.64	
CO	0.1657	4.64	0.1192	3.34	
CO_2	0.3888	17.11	0.4357	19.17	
	4.2275	100.01	4.2258	100.00	Total

Hydrazine-UDMH-Nitrogen Tetroxide

35.714 % UDMH-N_2H_4(50/50)
64.286 % N_2O_4

P_c 500 (psia)
T_c 3261 (^oK)

P_e	6.67	P_e	0.83 (psia)
T_e	1696	T_e	1125 ^oK
ϵ	9.48	ϵ	44.71
I_{sp}	288.7	I_{sp}	325.1 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.8727	33.74	1.7615	31.74	
H_2	0.4299	0.87	0.5416	1.09	
N_2	1.5532	43.52	1.5532	43.52	
CO	0.2666	7.47	0.1553	4.35	
CO_2	0.3275	14.41	0.4392	19.33	
	4.4499	100.01	4.4508	100.03	Total

Hydrazine-UDMH-Nitrogen Tetroxide

40.00	%	UDMH-N_2H_4(50/50)
60.00	%	N_2O_4
	%	
	%	

P_c 500 (psia)

T_c 3113 (^oK)

P_e	5.00	P_e	0.83	(psia)
T_e	1353	T_e	937	^oK
ϵ	10.95	ϵ	41.46	
I_{sp}	290.2	I_{sp}	318.2	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.6381	29.51	1.4706	26.49	
H_2	0.9411	1.90	1.1081	2.23	
N_2	1.6090	45.08	1.6090	45.08	
CO	0.3611	10.11	0.1936	5.42	
CO_2	0.3043	13.40	0.4718	20.77	
	4.8536	100.00	4.8531	99.99	Total

Hydrazine-UDMH-Nitrogen Tetroxide

30.303	%	UDMH-N_2H_4(50/50)
69.697	%	N_2O_4
	%	
	%	

P_c 700 (psia)

T_c 3310 (^oK)

P_e	9.33	P_e	1.75	(psia)
T_e	2052	T_e	1545	^oK
ϵ	10.67	ϵ	38.16	
I_{sp}	286.2	I_{sp}	320.3	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.9383	34.92	1.9524	35.17	
H_2	0.0104	0.02	0.0008	00.00	
H	0.0004	00.00	0.0000	00.00	
OH	0.0104	0.18	0.0012	0.02	
O_2	0.0400	1.28	0.0334	1.07	
O	0.0004	00.00	0.0000	00.00	
NO	0.0056	0.17	0.0012	0.03	
N_2	1.4796	41.46	1.4818	41.52	
CO	0.0128	0.36	0.0004	0.01	
CO_2	0.4914	21.63	0.5036	22.16	
	3.9893	100.02	3.9748	99.98	Total

Hydrazine-UDMH-Nitrogen Tetroxide

31.250 % UDMH-N_2H_4(50/50)
68.750 % N_2O_4
%
%

P_c 700 (psia)
T_c 3320 (^oK)

P_e	9.33	P_e	1.75	(psia)
T_e	2053	T_e	1527	^oK
ϵ	10.65	ϵ	37.69	
I_{sp}	288.4	I_{sp}	322.5	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.9760	35.60	1.9766	35.61	
H_2	0.0355	0.07	0.0383	0.08	
H	0.0012	00.00	0.0000	00.00	
OH	0.0056	0.09	0.0000	00.00	
O_2	0.0036	0.12	0.0000	00.00	
NO	0.0016	0.05	0.0000	00.00	
N_2	1.4938	41.86	1.4946	41.88	
CO	0.0424	1.19	0.0282	0.79	
CO_2	0.4776	21.02	0.4916	21.64	
	4.0373	100.00	4.0293	100.00	Total

Hydrazine-UDMH-Nitrogen Tetroxide

33.333 % UDMH-N_2H_4(50/50)
66.667 % N_2O_4
%
%

P_c 700 (psia)
T_c 3324 (^oK)

P_e	9.33	1.75	(psia)
T_e	1872	1362	^oK
ϵ	9.97	34.83	
I_{sp}	289.9	322.0	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.9540	35.20	1.9075	34.36	
H_2	0.1948	0.39	0.2417	0.49	
H	0.0008	00.00	0.0000	00.00	
OH	0.0004	00.00	0.0000	00.00	
N_2	1.5229	42.67	1.5217	42.64	
CO	0.1657	4.64	0.1192	3.34	
CO_2	0.3888	17.11	0.4357	19.17	
	4.2275	100.01	4.2258	100.00	Total

Hydrazine-UDMH-Nitrogen Tetroxide

35.714	%	UDMH-N_2H_4(50/50)
64.286	%	N_2O_4
	%	
	%	

P_c 700 (psia)

T_c 3292 (^oK)

P_e	9.33	P_e	1.17	(psia)
T_e	1692	T_e	1123	^oK
ϵ	9.43	ϵ	44.48	
I_{sp}	289.0	I_{sp}	325.2	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.8723	33.73	1.7606	31.72	
H_2	0.4308	0.87	0.5425	1.09	
N_2	1.5532	43.52	1.5532	43.52	
CO	0.2661	7.45	0.1544	4.32	
CO_2	0.3280	14.44	0.4397	19.35	
	4.4504	100.01	4.4504	100.00	Total

Hydrazine-UDMH-Nitrogen Tetroxide

40.00 % UDMH-N_2H_4(50/50)
60.00 % N_2O_4

P_c 700 (psia)
T_c 3132 (^oK)

P_e	7.00	1.17	(psia)
T_e	1352	936	^oK
ϵ	10.92	41.37	
I_{sp}	290.3	318.2	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	1.6381	29.51	1.4701	26.48	
H_2	0.9411	1.90	1.1086	2.23	
N_2	1.6090	45.08	1.6090	45.08	
CO	0.3611	10.11	0.1932	5.41	
CO_2	0.3048	13.42	0.4722	20.79	
	4.8541	100.02	4.8531	99.99	Total

PERFORMANCE - MISCELLANEOUS SYSTEMS

Hydrazine-Fluorine

Shifting Equilibrium

p_c = 100

P_e	r = 1.60		r = 1.80		r = 2.00		r = 2.20		r = 2.40	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	255.8	1.80	257.1	1.81	257.6	1.83	257.0	1.85	255.7	1.85
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	319.1	12.50	321.3	12.68	322.3	13.04	320.7	13.38	319.9	13.54
4	350.6	4.52	352.9	4.54	354.7	4.67	354.2	4.80	352.4	4.89
6	365.3	2.56	368.5	2.59	369.7	2.63	370.3	2.80	368.7	2.84
8	374.9	1.73	378.2	1.75	379.9	1.82	381.0	1.90	379.6	1.97
10	381.0	1.24	384.4	1.28	386.7	1.34	387.9	1.39	386.6	1.46
15	391.1	0.72	394.8	0.74	397.4	0.77	399.0	0.80	398.3	0.84
20	397.2	0.47	401.3	0.49	404.5	0.52	406.2	0.54	405.9	0.58
25	401.7	0.34	406.0	0.37	409.2	0.39	411.2	0.41	411.2	0.43
30	405.0	0.28	409.7	0.29	412.8	0.30	415.1	0.32	415.3	0.33
40	409.0	0.18	414.6	0.19	418.0	0.20	420.7	0.21	421.0	0.22
50	412.8	0.13	417.7	0.14	421.5	0.15	424.3	0.16	424.6	0.16
$\Delta I/_{\epsilon} P_a$	2.176		2.187		2.189		2.183		2.171	

Hydrazine-Fluorine

Shifting Equilibrium

$P_c = 150$

P_e	r = 1.60		r = 1.80		r = 2.00		r = 2.20		r = 2.40	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	278.8	2.33	280.5	2.35	281.3	2.38	281.0	2.41	279.7	2.42
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
3	340.3	10.67	342.5	10.79	344.2	11.01	343.5	11.19	342.0	11.29
5	360.9	5.00	363.4	5.17	364.8	5.24	365.0	5.48	364.0	5.54
7	371.3	3.02	374.7	3.13	377.5	3.17	377.7	3.36	376.2	3.42
10	382.1	1.86	385.5	1.90	388.0	1.97	389.2	2.07	388.2	2.13
12	386.8	1.44	390.4	1.47	392.8	1.52	394.7	1.60	393.8	1.67
15	392.1	1.04	396.0	1.07	398.6	1.15	400.6	1.19	399.9	1.23
20	398.2	0.70	402.4	0.73	405.7	0.76	407.7	0.80	407.3	0.83
25	402.5	0.50	407.0	0.53	410.2	0.57	412.8	0.60	412.7	0.63
30	405.8	0.40	410.3	0.43	413.8	0.45	416.3	0.47	416.7	0.48
40	410.2	0.26	415.0	0.28	419.3	0.29	421.8	0.30	422.1	0.32
50	413.4	0.19	418.4	0.20	422.3	0.21	425.3	0.23	425.6	0.24
$\Delta I/_{\epsilon} P_a$	1.458		1.466		1.468		1.464		1.456	

Hydrazine-Fluorine

Shifting Equilibrium

p_C = 200

P_e	r = 1.60		r = 1.80		r = 2.00		r = 2.20		r = 2.40	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	293.4	2.81	295.3	2.84	296.4	2.89	296.4	2.93	295.1	2.95
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
3	341.0	13.70	343.9	13.90	344.5	14.10	344.5	14.70	343.0	14.60
5	361.3	6.40	364.5	6.55	366.0	6.70	356.0	7.10	365.0	7.28
7	373.2	4.00	376.7	4.12	377.8	4.30	379.2	4.45	377.3	4.55
10	383.3	2.40	386.5	2.50	389.0	2.62	390.6	2.73	389.3	2.80
12	387.7	1.86	391.3	1.92	394.0	2.00	395.7	2.08	394.9	2.15
15	392.9	1.39	396.7	1.42	399.7	1.44	401.5	1.56	401.1	1.60
20	399.1	0.86	403.2	0.94	406.2	0.96	408.6	1.02	408.3	1.07
25	403.1	0.62	407.8	0.67	411.1	0.72	413.8	0.74	413.4	0.76
30	406.1	0.53	411.1	0.56	414.7	0.59	417.4	0.61	417.2	0.62
40	410.4	0.35	415.5	0.36	419.5	0.38	422.6	0.40	422.9	0.41
50	413.8	0.24	418.9	0.26	422.9	0.28	425.9	0.30	426.3	0.31
$\Delta I/_{\epsilon}P_a$	1.097		1.103		1.105		1.103		1.097	

Hydrazine-Fluorine

Shifting Equilibrium

P_c = 500

P_e	r = 1.60		r = 1.80		r = 2.00		r = 2.20		r = 2.40	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	332.0	5.20	334.9	5.30	337.0	5.41	337.9	5.55	337.0	5.65
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
6	370.5	12.10	373.8	12.36	376.1	12.70	377.0	13.10	376.0	13.37
8	379.2	7.95	382.9	8.20	385.2	8.68	386.7	8.95	385.9	9.30
10	385.2	5.75	389.2	5.95	391.8	6.20	393.7	6.43	393.0	6.72
12	389.8	4.44	393.8	4.63	396.7	4.79	398.6	4.92	398.2	5.25
15	394.9	3.23	399.0	3.40	402.1	3.52	404.4	3.68	404.2	3.90
20	400.5	2.10	405.3	2.20	408.7	2.35	411.2	2.45	411.3	2.55
25	404.6	1.53	409.5	1.57	413.1	1.69	415.8	1.75	416.0	1.80
30	407.6	1.18	412.7	1.20	416.6	1.27	419.4	1.35	419.7	1.39
35	409.9	0.96	415.1	1.00	419.3	1.05	422.2	1.10	422.7	1.12
40	411.7	0.83	416.9	0.87	421.1	0.91	424.3	0.95	424.8	0.97
50	414.9	0.59	420.3	0.61	424.6	0.65	427.8	0.70	428.3	0.73
$\Delta I / \epsilon P_a$	0.444		0.446		0.447		0.447		0.445	

Hydrazine-Chlorine Trifluoride

Shifting Equilibrium

$p_c = 150$

P_e	r = 2.00		r = 2.20		r = 2.40		r = 2.60		r = 2.80	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	232.0	2.25	232.3	2.27	232.5	2.29	232.3	2.30	231.8	2.31
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
3	282.4	8.80	283.0	9.30	284.0	9.60	284.5	9.60	282.0	9.60
5	297.8	4.40	298.8	4.40	299.6	4.70	300.8	4.80	299.5	4.85
7	306.0	2.70	307.4	2.65	308.6	2.80	308.8	2.80	309.0	2.90
9	311.4	1.82	313.0	1.90	314.3	1.93	314.5	2.02	314.6	2.10
12	316.4	1.22	318.2	1.24	319.5	1.30	320.4	1.35	320.6	1.40
15	320.0	0.88	322.0	0.88	323.0	0.92	324.8	0.96	325.0	1.00
20	324.8	0.58	326.8	0.60	328.0	0.61	329.0	0.60	330.0	0.60
25	327.5	0.41	329.5	0.45	331.2	0.48	332.3	0.48	333.2	0.48
30	329.5	0.33	332.0	0.33	333.5	0.38	335.0	0.39	335.5	0.32
40	332.7	0.20	335.0	0.25	336.9	0.20	338.4	0.20	339.0	0.22
50	334.7	0.10	337.2	0.12	339.2	0.13	340.8	0.15	341.9	0.18
$\Delta I / \epsilon P_a$	1.218		1.219		1.218		1.216		1.213	

Hydrazine-Chlorine Trifluoride

Shifting Equilibrium

$P_c = 300$

P_e	r = 2.00		r = 2.20		r = 2.40		r = 2.60		r = 2.80	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	257.5	3.45	258.4	3.51	258.8	3.57	259.1	3.62	258.9	3.65
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
4	292.0	11.50	294.0	11.60	294.8	11.85	295.0	11.90	294.4	12.35
6	302.5	6.50	305.2	6.60	306.0	6.80	306.0	6.90	306.0	7.15
8	310.0	4.18	311.8	4.28	312.3	4.40	313.3	4.55	313.0	4.75
10	314.0	3.05	316.0	3.10	317.0	3.20	318.0	3.26	318.0	3.45
12	317.4	2.36	319.0	2.38	320.0	2.45	321.5	2.56	321.8	2.70
15	321.0	1.66	323.0	1.75	324.0	1.80	325.8	1.88	326.0	2.00
20	324.8	1.08	327.0	1.15	328.8	1.20	330.0	1.22	330.8	1.30
25	327.6	0.75	329.5	0.80	331.9	0.88	333.0	0.89	334.0	0.90
30	330.0	0.60	332.0	0.65	334.0	0.66	335.4	0.67	336.4	0.70
40	333.0	0.43	335.5	0.56	337.0	0.58	339.0	0.50	340.0	0.50
50	335.0	0.30	337.6	0.30	340.0	0.32	341.4	0.34	342.5	0.36
$\Delta I/_{\epsilon} P_a$	0.612		0.613		0.613		0.612		0.611	

Hydrazine-Chlorine Trifluoride

Shifting Equilibrium

$p_c = 500$

P_e	r = 2.00		r = 2.20		r = 2.40		r = 2.60		r = 2.80	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	272.5	4.78	273.8	4.87	274.8	4.96	275.3	5.05	275.3	5.14
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
6	304.0	10.25	305.0	10.85	306.0	10.95	307.0	11.10	307.0	11.60
8	310.0	6.84	312.0	6.95	312.5	7.35	313.5	7.50	314.0	7.76
10	314.4	5.00	316.0	5.10	317.5	5.30	318.3	5.48	319.0	5.70
12	317.4	3.80	319.5	3.90	321.0	4.00	322.0	4.20	322.3	4.30
14	320.0	3.06	322.0	3.08	324.0	3.18	324.5	3.30	325.0	3.45
16	322.0	2.50	324.2	2.56	326.0	2.65	326.0	2.70	327.6	2.89
20	325.0	1.80	327.0	1.88	329.0	1.93	330.5	2.00	331.0	2.10
25	328.0	1.28	330.0	1.36	331.8	1.40	333.5	1.46	334.0	1.50
30	330.0	1.00	332.5	1.08	334.0	1.10	336.0	1.10	337.0	1.18
40	333.0	0.65	335.2	0.70	337.5	0.72	339.0	0.75	341.0	0.82
50	335.2	0.48	337.8	0.50	340.0	0.51	341.7	0.53	344.9	0.56
$\Delta I/_{\epsilon} P_a$	0.369		0.369		0.369		0.369		0.368	

Hydrazine-SFNA

Shifting Equilibrium

P_c = 150

P_e	r = 1.1		r = 1.3		r = 1.5		r = 1.7		r = 1.9	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	224.8	2.24	225.8	2.30	223.8	2.38	218.2	2.35	212.2	2.32
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
3	274.5	9.10	276.0	9.35	274.2	9.90	266.3	9.65	259.7	10.00
5	280.9	4.45	291.5	4.70	290.5	5.00	282.3	4.95	274.1	4.85
7	297.0	2.70	299.7	2.87	300.0	3.10	291.5	2.95	282.5	2.92
9	302.5	1.93	305.8	2.05	306.0	2.20	297.0	2.15	288.0	2.10
11	306.5	1.47	310.0	1.53	310.5	1.70	301.3	1.63	292.0	1.60
15	312.3	0.95	315.9	1.00	316.9	1.10	307.5	1.07	297.5	1.03
20	316.5	0.62	320.5	0.68	322.0	0.73	312.3	0.73	302.2	0.70
25	319.8	0.45	324.1	0.50	325.8	0.54	315.8	0.53	305.6	0.50
30	322.2	0.38	326.8	0.38	328.6	0.42	318.5	0.40	308.1	0.38
40	325.6	0.24	330.4	0.27	332.7	0.32	322.4	0.28	311.7	0.27
50	328.1	0.18	333.1	0.20	335.7	0.22	325.1	0.21	314.3	0.20
$\Delta I/_{\epsilon} P_a$	1.182		1.184		1.168		1.141		1.111	

Hydrazine-SFNA

Shifting Equilibrium

p_c = 300

P_e	r = 1.1		r = 1.3		r = 1.5		r = 1.7		r = 1.9	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	248.9	3.51	250.9	3.61	250.1	3.80	243.2	3.73	235.9	3.67
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
4	283.5	12.00	285.5	12.40	284.8	13.50	278.0	13.25	268.5	12.75
6	294.0	6.85	296.7	7.15	296.7	7.70	288.7	7.50	279.0	7.35
8	300.2	4.50	303.7	4.75	304.3	5.15	294.9	5.00	285.8	4.80
10	304.8	3.25	308.5	3.43	309.5	3.75	299.8	3.60	290.5	3.53
12	308.2	2.55	312.0	2.70	313.1	2.95	303.5	2.88	293.8	2.75
15	312.2	1.85	316.0	1.98	317.5	2.20	307.7	2.12	297.8	2.02
20	316.8	1.25	321.0	1.35	322.9	1.47	312.7	1.42	302.5	1.37
25	320.0	0.90	324.4	0.98	326.6	1.08	316.2	1.06	305.8	1.00
30	324.3	0.72	327.0	0.75	329.5	0.85	318.9	0.82	308.2	0.79
40	325.8	0.49	330.6	0.53	333.4	0.58	322.7	0.56	311.8	0.54
50	328.2	0.43	333.2	0.38	336.3	0.43	325.4	0.41	314.5	0.40
$\Delta I/_{\epsilon} P_a$	0.592		0.594		0.587		0.572		0.557	

Hydrazine-SFNA

Shifting Equilibrium

$P_c = 500$

P_e	r = 1.1		r = 1.3		r = 1.5		r = 1.7		r = 1.9	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7			266.0	5.12	266.0	5.41	258.3	5.30	250.3	5.21
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
6			297.0	11.65	296.5	12.75	288.2	12.35	279.5	12.00
7			300.8	9.30	300.5	10.15	292.5	9.85	283.0	9.70
8			303.7	7.80	304.0	8.45	295.5	8.20	285.8	8.10
10			308.5	5.75	309.0	6.20	300.1	6.05	290.6	5.85
12			312.2	4.45	313.0	4.85	303.8	4.73	294.0	4.60
15			316.3	3.27	317.4	3.54	308.0	3.45	298.1	3.37
20			321.0	2.23	322.5	2.43	313.0	2.34	302.8	2.27
25			324.5	1.63	326.3	1.80	316.3	1.77	306.0	1.70
30			327.1	1.26	329.2	1.40	319.0	1.35	308.4	1.28
40			330.7	0.86	332.2	0.96	322.8	0.93	312.0	0.90
50			333.5	0.64	336.1	0.71	325.5	0.69	314.6	0.64
$\Delta I/_{\epsilon}P_a$			0.357		0.353		0.344		0.335	

Hydrogen-Oxygen

Shifting Equilibrium

Pc = 60

P_e	r = 3.00		r = 4.00		r = 5.00		r = 6.00		r =	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	255.8	1.29	252.1	1.33	244.2	1.36	235.0	1.37		
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	362.0	6.25	359.7	7.36	351.5	7.93	338.5	8.42		
4	395.2	2.24	394.5	2.50	386.6	2.79	374.3	3.07		
6	408.6	1.23	409.7	1.40	403.7	1.58	391.7	1.75		
8	416.8	0.81	418.7	0.94	413.6	1.07	403.1	1.20		
10	422.6	0.58	425.5	0.68	420.9	0.78	411.3	0.89		
15	431.6	0.34	436.0	0.39	432.7	0.45	424.0	0.55		
20	437.3	0.21	442.4	0.26	439.9	0.30	432.2	0.36		
25	441.1	0.15	446.9	0.19	445.1	0.23	438.1	0.27		
30	444.1	0.11	450.2	0.15	449.2	0.18	442.7	0.21		
40	447.8	0.08	455.1	0.10	454.5	0.12	449.0	0.14		
50	451.0	0.06	458.3	0.08	458.5	0.09	453.7	0.10		
$\Delta I/_{\epsilon} P_a$	4.150		4.104		3.980		3.833			

Hydrogen-Oxygen

Shifting Equilibrium

$P_c = 100$

P_e	r = 3.00		r = 4.00		r = 5.00		r = 6.00		r =	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	291.6	1.70	289.2	1.77	281.9	1.83	272.2	1.87		
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	363.0	11.69	362.0	12.21	352.2	13.04	339.5	13.89		
4	394.8	3.80	394.8	4.17	388.0	4.50	376.5	4.82		
6	408.5	2.08	409.9	2.29	404.5	2.58	394.1	2.88		
8	416.7	1.37	419.5	1.53	414.5	1.74	405.0	1.96		
10	422.9	0.98	425.9	1.12	421.8	1.28	412.8	1.44		
15	431.7	0.55	436.3	0.64	433.4	0.74	425.4	0.85		
20	437.2	0.37	442.5	0.43	440.8	0.50	433.5	0.59		
25	441.0	0.27	447.1	0.31	446.0	0.38	439.4	0.44		
30	444.1	0.21	450.4	0.24	449.7	0.29	443.8	0.35		
40	447.9	0.14	455.3	0.16	455.0	0.20	450.0	0.24		
50	451.1	0.10	458.5	0.13	459.0	0.15	454.7	0.18		
$\Delta I / \epsilon P_a$	2.489		2.468		2.399		2.313			

Hydrogen-Oxygen

Shifting Equilibrium

$P_c = 200$

P_e	r = 3.00		r = 4.00		r = 5.00		r = 6.00		r =	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	329.3	2.59	328.8	2.71	323.0	2.86	313.8	2.99		
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
3	383.5	11.70	383.2	12.50	375.3	13.50	365.5	14.50		
5	403.3	5.33	404.2	5.85	398.7	6.57	388.6	7.10		
7	413.7	3.30	415.6	3.70	411.0	4.10	402.2	4.58		
10	422.8	1.95	426.3	2.20	422.9	2.55	414.8	2.85		
12	427.0	1.47	431.0	1.75	428.1	1.98	420.3	2.21		
15	431.8	1.10	436.7	1.23	434.3	1.45	427.2	1.67		
20	437.2	0.73	442.9	0.83	441.4	1.00	435.1	1.13		
25	441.2	0.50	447.2	0.60	446.4	0.75	440.8	0.82		
30	444.1	0.39	450.7	0.45	450.3	0.57	445.1	0.63		
40	447.9	0.29	455.5	0.33	455.7	0.40	451.3	0.46		
50	451.1	0.20	458.7	0.25	459.6	0.30	456.0	0.34		
$\Delta I/_{\epsilon} P_a$	1.245		1.238		1.207		1.166			

Hydrogen-Oxygen
Shifting Equilibrium
p_c = 300

P_e	r = 3.00		r = 4.00		r = 5.00		r = 6.00		r =	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	347.2	3.36	347.8	3.54	343.0	3.76	334.5	3.97		
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
4	395.1	11.35	395.7	12.35	389.6	13.45	380.0	14.45		
6	408.7	6.15	410.5	6.80	406.3	7.55	397.3	8.30		
8	416.8	4.10	419.9	4.53	416.5	5.13	407.8	5.73		
10	422.9	2.93	426.3	3.33	423.3	3.70	415.7	4.23		
12	427.1	2.27	431.1	2.57	428.4	2.93	421.5	3.30		
15	431.8	1.65	436.7	1.88	434.7	2.17	428.0	2.46		
20	437.3	1.10	443.1	1.24	442.2	1.45	436.0	1.66		
25	441.2	0.79	447.7	0.91	447.0	1.08	441.6	1.22		
30	444.1	0.60	450.8	0.70	450.8	0.85	445.8	0.98		
40	447.9	0.43	455.6	0.49	456.0	0.59	451.9	0.69		
50	451.1	0.30	458.8	0.37	459.9	0.44	456.7	0.50		
$\Delta I/_{\epsilon} P_a$	0.830		0.826		0.807		0.780			

Hydrogen-Fluorine

Shifting Equilibrium

$P_c = 100$

P_e	r = 5		r = 10		r = 13		r = 17		r = 20	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	304.7	1.72	293.0	1.81	288.1	1.82	280.8	1.86	274.1	1.86
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	381.4	11.68	367.5	12.60	361.0	13.30	353.5	13.44	343.0	13.30
4	413.3	3.66	403.0	4.60	397.1	4.72	388.0	4.90	379.0	5.00
6	426.7	1.98	420.4	2.58	414.4	2.75	406.4	2.80	396.7	2.90
8	435.1	1.26	431.1	1.80	425.5	1.85	417.3	1.94	407.3	2.00
10	440.9	0.84	438.2	1.32	433.0	1.40	425.1	1.52	415.4	1.55
15	449.8	0.56	450.3	0.72	445.5	0.80	438.9	0.86	428.8	0.92
20	454.7	0.32	458.0	0.46	454.0	0.56	447.6	0.60	437.7	0.62
25	458.1	0.20	463.2	0.33	459.4	0.38	454.1	0.42	444.0	0.43
30	461.1	0.15	467.9	0.25	463.8	0.27	458.9	0.28	448.8	0.33
40	465.1	0.10	472.5	0.18	469.9	0.22	464.9	0.24	454.6	0.24
50	467.6	0.10	476.4	0.12	474.6	0.16	470.2	0.18	459.4	0.17
$\Delta I/_{\epsilon} P_a$	2.60		2.49		2.45		2.38		2.33	

Hydrogen-Fluorine

Shifting Equilibrium

$P_c = 200$

P_e	r = 5		r = 10		r = 13		r = 17		r = 20	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	345.1	2.57	336.7	2.85	331.7	2.88	324.4	2.97	316.8	2.97
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	381.3	23.00	370.5	25.00	369.0	25.30	355.0	26.00	344.6	26.30
4	413.6	7.08	406.4	9.12	400.5	9.20	391.5	9.70	382.7	9.80
6	427.4	3.95	423.0	4.82	417.4	5.38	410.3	5.54	400.1	5.72
8	435.7	2.60	433.5	3.42	428.1	3.56	421.0	3.79	411.4	3.83
10	441.5	1.80	440.7	2.56	435.6	2.66	428.9	2.84	419.0	3.00
15	450.0	1.00	452.7	1.40	448.2	1.59	442.1	1.72	432.6	1.77
20	455.3	0.66	460.1	0.96	456.5	1.08	450.9	1.18	441.1	1.23
25	458.9	0.50	465.0	0.66	462.2	0.78	457.0	0.86	447.2	0.91
30	461.3	0.36	468.9	0.52	466.3	0.58	461.7	0.72	451.5	0.64
40	465.4	0.20	474.0	0.35	472.2	0.42	467.9	0.51	457.4	0.47
50	467.9	0.17	474.7	0.21	476.7	0.30	473.0	0.35	461.8	0.32
$\Delta I/_{\epsilon} P_a$	1.31		1.26		1.24		1.21		1.18	

Methyl Hydrazine-SFNA

Shifting Equilibrium

$P_c = 150$

P_e	r = 2.0		r = 2.2		r = 2.4		r = 2.6		r = 2.8	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	221.1	2.31	221.2	2.37	219.9	2.43	217.6	2.45	214.7	2.44
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	255.0	18.13	254.6	19.38	254.1	19.63	249.8	20.00	246.1	19.85
4	278.7	6.45	280.1	6.50	279.1	7.08	276.5	7.48	272.4	7.43
6	289.7	3.58	291.6	3.75	291.2	4.05	289.3	4.30	285.9	4.28
8	297.0	2.43	298.6	2.58	299.0	2.69	297.2	2.83	292.6	2.75
10	302.1	1.85	303.6	1.93	304.1	2.05	302.9	2.25	298.0	2.20
15	309.9	1.08	311.9	1.13	313.0	1.16	312.2	1.25	307.2	1.24
20	315.0	0.68	317.3	0.74	318.3	0.78	318.0	0.88	313.0	0.83
25	318.6	0.53	321.1	0.55	322.5	0.58	322.2	0.65	317.0	0.61
30	321.2	0.45	323.9	0.46	325.5	0.49	325.4	0.51	320.1	0.50
40	325.0	0.28	328.0	0.30	329.8	0.33	330.1	0.36	324.4	0.35
50	327.9	0.20	330.9	0.20	332.9	0.21	332.3	0.24	327.7	0.23
$\Delta I/_{\epsilon}P_a$	1.159		1.156		1.146		1.132		1.118	

Methyl Hydrazine-SFNA

Shifting Equilibrium

$P_c = 300$

P_e	r = 2.0		r = 2.2		r = 2.4		r = 2.6		r = 2.8	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	245.8	3.64	246.7	3.74	246.4	3.88	244.3	3.99	240.8	3.96
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	255.6	38.52	255.1	40.00	255.0	41.34	250.7	41.76	247.6	41.59
4	280.0	12.15	280.6	12.80	280.0	14.20	278.6	14.60	273.7	14.38
6	290.8	6.93	292.2	7.50	292.2	8.05	291.5	8.44	286.2	8.25
8	297.4	4.88	299.3	5.00	299.8	5.33	298.4	5.83	293.8	5.54
10	302.7	3.57	304.3	3.66	305.0	3.98	303.9	4.28	299.0	4.05
15	310.2	2.03	312.8	2.18	313.9	2.28	313.2	2.49	308.1	2.43
20	315.1	1.40	317.9	1.50	319.0	1.57	319.0	1.69	313.7	1.68
25	318.8	1.03	321.5	1.08	323.1	1.24	323.2	1.28	317.8	1.25
30	321.3	0.76	324.1	0.81	325.8	0.91	326.3	0.98	320.5	0.95
40	325.3	0.57	328.3	0.59	330.3	0.62	330.8	0.65	325.0	0.64
50	328.1	0.45	331.3	0.48	333.4	0.50	334.1	0.54	328.2	0.52
$\Delta I/_{\epsilon} P_a$	0.581		0.580		0.576		0.570		0.562	

Methyl Hydrazine-SFNA

Shifting Equilibrium

P_c = 500

P_e	r = 2.0		r = 2.2		r = 2.4		r = 2.6		r = 2.8	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	260.7	5.18	262.2	5.33	262.5	5.53	261.0	5.77	257.1	5.70
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	256.1	63.65	256.2	65.86	254.4	68.16	250.6	69.30	247.6	69.10
4	280.4	20.70	281.6	22.25	281.1	23.10	279.2	24.00	273.9	23.83
6	291.3	12.03	292.6	12.50	294.3	13.00	291.3	14.15	286.4	13.83
8	298.0	8.10	299.7	8.40	300.6	8.61	299.2	9.50	293.8	9.38
10	302.9	6.05	304.8	6.15	305.8	6.50	304.9	7.00	299.1	6.95
15	310.5	3.43	313.0	3.55	314.5	3.90	314.0	4.10	308.4	4.03
20	315.6	2.33	318.3	2.48	319.6	2.50	319.6	2.77	313.7	2.74
25	319.2	1.80	321.9	1.90	323.5	1.98	323.8	2.03	317.8	2.01
30	321.7	1.33	324.6	1.40	326.2	1.50	326.8	1.54	320.5	1.53
40	325.4	0.94	328.5	0.98	330.6	1.03	331.3	1.10	325.4	1.08
50	328.2	0.70	331.5	0.74	333.7	0.80	334.6	0.86	328.6	0.84
$\Delta I/_{\epsilon} P_a$	0.349		0.349		0.347		0.343		0.338	

Methyl Hydrazine-N_2O_4

Shifting Equilibrium

$P_c = 150$

P_e	r = 1.5		r = 1.7		r = 1.9		r = 2.1		r = 2.3	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	224.0	2.24	225.7	2.30	225.8	2.38	224.3	2.44	221.9	2.47
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	258.8	18.60	259.4	12.00	259.8	19.75	256.8	20.00	254.2	21.10
4	281.9	6.05	284.7	6.25	286.1	6.75	284.5	7.25	282.0	7.50
6	292.5	3.35	296.1	3.58	297.6	3.79	297.2	4.03	295.1	4.15
8	299.5	2.25	303.1	2.45	305.0	2.57	305.0	2.74	303.3	3.02
10	304.0	1.70	308.1	1.79	310.3	1.97	311.0	2.01	309.3	2.26
15	311.0	1.00	316.0	1.03	319.0	1.08	320.0	1.18	319.2	1.28
20	316.0	0.65	320.9	0.68	324.1	0.72	325.6	0.74	325.3	0.89
25	319.1	0.49	324.6	0.52	328.0	0.53	329.7	0.54	329.8	0.63
30	321.1	0.41	327.2	0.43	330.5	0.44	332.7	0.48	333.0	0.52
40	325.4	0.25	331.0	0.27	335.0	0.29	337.3	0.33	337.9	0.37
50	328.1	0.20	333.8	0.20	338.0	0.20	340.5	0.22	341.4	0.25
$\Delta I/_{\epsilon} P_a$	1.178		1.183		1.179		1.168		1.154	

Methyl Hydrazine-N_2O_4

Shifting Equilibrium

P_c = 300

P_e	r = 1.5		r = 1.7		r = 1.9		r = 2.1		r = 2.3	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	248.1	3.51	251.0	3.62	252.2	3.76	251.7	3.92	249.6	4.04
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	257.8	36.00	260.7	36.60	261.0	37.75	258.6	39.75	255.6	40.75
4	282.9	12.15	283.8	12.68	287.1	13.35	286.1	14.60	283.6	14.92
6	293.0	6.88	296.8	7.05	298.5	7.56	298.7	8.14	296.7	8.56
8	299.7	4.58	303.9	4.73	306.3	5.05	306.5	5.39	305.0	5.76
10	304.1	3.31	308.6	3.50	311.2	3.65	311.9	3.99	310.8	4.33
15	311.5	1.93	316.3	2.00	319.6	2.18	320.8	2.28	320.5	2.50
20	316.1	1.30	321.1	1.38	324.8	1.49	326.5	1.54	326.5	1.75
25	319.5	0.95	324.8	1.02	328.6	1.07	330.6	1.18	330.9	1.25
30	322.0	0.70	327.3	0.76	331.1	0.81	333.3	0.92	334.0	1.01
40	325.6	0.54	331.3	0.56	335.4	0.59	338.0	0.62	338.9	0.66
50	328.4	0.41	334.1	0.44	338.4	0.47	341.2	0.51	342.3	0.54
$\Delta I/_{\epsilon}P_a$	0.590		0.594		0.593		0.588		0.581	

Methyl Hydrazine-N_2O_4

Shifting Equilibrium

$P_c = 500$

P_e	r = 1.5		r = 1.7		r = 1.9		r = 2.1		r = 2.3	
	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ	I_s (max)	ϵ
14.7	262.6	4.97	266.2	5.13	268.2	5.32	268.6	5.57	267.1	5.85
ϵ	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e	I_v	P_e
2	258.7	57.50	261.9	62.0	261.6	63.0	260.2	63.50	257.1	65.00
4	282.6	20.30	285.9	20.75	287.5	21.85	287.3	23.25	285.1	24.80
6	292.9	11.00	297.0	11.70	299.2	12.50	299.6	13.10	297.0	13.78
8	299.8	7.35	304.0	7.86	306.6	8.30	307.3	8.91	306.0	9.70
10	304.4	5.45	308.8	5.63	311.6	6.00	312.9	6.50	311.9	7.01
15	311.7	3.25	317.0	3.29	320.1	3.53	321.7	3.85	321.3	4.02
20	316.0	2.13	321.5	2.27	325.0	2.49	327.0	2.53	327.3	2.96
25	319.5	1.57	325.0	1.72	329.8	1.85	331.0	1.98	331.5	2.13
30	322.0	1.20	327.6	1.30	331.5	1.41	334.0	1.54	334.8	1.68
40	325.8	0.89	331.5	0.92	335.7	0.97	338.4	1.03	339.5	1.11
50	328.6	0.62	334.3	0.67	338.7	0.73	341.6	0.80	342.9	0.87
$\Delta I / \epsilon P_a$	0.354		0.357		0.357		0.354		0.350	

GAS COMPOSTION-MISCELLANEOUS SYSTEMS

Aluminum - Ammonium Perchlorate - PBAA

66	%	NH_4ClO_4
18	%	Al
16	%	PBAA Binder
	%	

P_c 700 (psia)

T_c 3168 (^oK)

P_e	8.75	P_e	1.75	(psia)
T_e	1735	T_e	1293	^oK
ϵ	10.69	ϵ	35.94	
I_{sp}	263.8	I_{sp}	292.3	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	0.1740	3.13	0.1491	2.69
H_2	1.5353	3.10	1.5605	3.14
H	0.0000	00.00	0.0000	00.00
HCl	0.5616	20.48	0.5616	20.48
N_2	0.2953	8.27	0.2953	8.27
CO	1.1844	33.18	1.1594	32.47
CO_2	0.0364	1.60	0.0608	2.67
$Al_2O_3(l, s)$	0.2965	30.22	0.2965	30.22
Total	4.0843	99.98	4.0832	99.95

Aluminum - Ammonium Perchlorate - PBAA

74	%	NH_4ClO_4
14	%	Al
12	%	PBAA Binder
	%	

P_c 700 (psia)

T_c 3357 (^oK)

P_e	8.75	P_e	2.33	(psia)
T_e	1918	T_e	15.33	^oK
ϵ	10.99	ϵ	30.07	
I_{sp}	264.5	I_{sp}	289.5	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	0.7914	14.26	0.7423	13.37	
H_2	0.8274	1.67	0.8772	1.77	
H	0.0019	00.00	0.0000	00.00	
HCl	0.6287	22.93	0.6295	22.96	
N_2	0.3261	9.15	0.3264	9.14	
CO	0.7812	21.88	0.7318	20.50	
CO_2	0.1683	7.41	0.2177	9.58	
$Al_2O_3(s,l)$	0.2223	22.66	0.2222	22.65	
	3.7473	99.96	3.7471	99.97	Total

Aluminum - Ammonium Perchlorate - PBAA

74	%	NH_4ClO_4
18	%	Al
08	%	PBAA Binder
	%	

P_c 700 (psia)

T_c 2955 (^oK)

P_e	8.75	1.75	(psia)
T_e	1423	1052	^oK
ϵ	9.84	33.05	
I_{sp}	254.5	280.0	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	0.6803	12.26	0.5366	9.67	
H_2	1.1321	2.28	1.2757	2.57	
HCl	0.6298	22.97	0.6298	22.97	
N_2	0.3296	9.24	0.3296	9.24	
CO	0.9735	27.27	0.8298	23.24	
CO_2	0.2472	10.88	0.3909	17.20	
$Al_2O_3(s,l)$	0.1482	15.11	0.1482	15.11	
	4.1407	100.01	4.1406	100.00	Total

Aluminum - Ammonium Perchlorate - PBAA

70 % NH_4ClO_4
22 % Al
08 % PBAA Binder
%

P_c 700 (psia)
T_c 2595 (^oK)

P_e	8.75	1.75	(psia)
T_e	1149	875	^oK
ϵ	9.32	31.91	
I_{sp}	244.9	268.3	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %
H_2O	0.3276	5.90	0.2135	3.85
H2	1.6257	3.28	1.6741	3.37
HCl	0.5957	21.72	0.5958	21.73
N_2	0.3158	8.85	0.3156	8.84
CO	1.2828	35.93	1.1028	30.89
CO_2	0.2091	9.20	0.3560	15.67
CH_4	0.0004	0.01	0.0333	0.53
Al_2O_3(s,l)	0.1482	15.11	0.1483	15.12
Total	4.5053	100.00	4.4394	100.00

Aluminum - Ammonium Perchlorate - PBAA

70	%	NH_4ClO_4
18	%	Al
12	%	PBAA Binder
	%	

P_c 700 (psia)

T_c 3080 (^oK)

P_e	8.75	P_e	2.33	(psia)
T_e	1571	T_e	1228	^oK
ϵ	10.23	ϵ	27.56	
I_{sp}	259.7	I_{sp}	282.5	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	
H_2O	0.4454	8.02	0.3829	6.89	
H_2	1.3157	2.65	1.3782	2.78	
HCl	0.5959	21.73	0.5959	21.73	
N_2	0.3126	8.76	0.3126	8.76	
CO	1.0973	30.74	1.0348	28.98	
CO_2	0.1234	5.43	0.1859	8.18	
$Al_2O_3(s,l)$	0.2225	22.68	0.2225	22.68	
	4.1128	100.01	4.1128	100.00	Total

Hydrazine - Hydrogen Peroxide

N_2H_4	%	33.0
H_2O_2	%	67.0
	%	
	%	

P_c 1000 psia	P_e	14.7	2.0 (psia)
T_c 2923 °K	T_e	1517	1031 °K
	ϵ	9.0	39.7
	I_{sp}	286	323 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.0156	0.02	0.0000	0.00	0.0000	0.00
O	0.0041	0.07	0.0000	0.00	0.0000	0.00
H_2	0.2098	0.42	0.0898	0.18	0.0897	0.18
H_2O	3.7664	67.86	3.9393	70.97	3.9393	70.97
O_2	0.0298	0.95	0.0000	0.00	0.0000	0.00
OH	0.0900	1.53	0.0000	0.00	0.0000	0.00
N_2	1.0200	28.58	1.0297	28.85	1.0297	28.85
NO	0.0193	0.58	0.0000	0.00	0.0000	0.00
Total	5.1550	100.01	5.0588	100.00	5.0587	100.00

Hydrazine - Fluorine

N_2H_4	%	45.0
F_2	%	55.0
	%	
	%	

P_c 1000 psia	P_e	14.7	2.0	(psia)
T_c 3959 °K	T_e	1769	1058	°K
	ϵ	8.0	31.8	
	I_{sp}	344	381	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.4648	0.47	0.0008	0.00	0.0000	0.00
N	0.0005	0.01	0.0000	0.00	0.0000	0.00
F	0.0268	0.51	0.0000	0.00	0.0000	0.00
H_2	1.1411	2.30	1.3605	2.74	1.3609	2.74
HF	2.8679	57.38	2.8947	57.92	2.8947	57.92
N_2	1.4033	39.32	1.4041	39.34	1.4041	39.34
NH	0.0008	0.01	0.0000	0.00	0.0000	0.00
NH_2	0.0004	0.01	0.0000	0.00	0.0000	0.00
Total	5.9056	100.01	5.6601	100.00	5.6597	100.00

Hydrazine - OF_2

N_2H_4	%	40.0
OF_2	%	60.0
	%	
	%	

P_c 1000 psia

T_c 4037 °K

P_e 14.7 — 2.0 (psia)

T_e 2415 — 1606 °K

ϵ 9.7 — 41.9

I_{sp} 345 — 391 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.3364	0.34	0.0198	0.02	0.0002	0.00
N	0.0006	0.01	0.0000	0.00	0.0000	0.00
O	0.0937	1.50	0.0007	0.01	0.0000	0.00
F	0.0363	0.69	0.0003	0.01	0.0000	0.00
H_2	0.5042	1.02	0.2768	0.56	0.2740	0.55
H_2O	0.8044	14.49	1.0911	19.66	1.1111	20.02
HF	2.1860	43.74	2.2220	44.46	2.2222	44.46
O_2	0.0445	1.42	0.0012	0.04	0.0000	0.00
OH	0.2530	4.30	0.0150	0.26	0.0000	0.00
N_2	1.2123	33.97	1.2472	34.95	1.2481	34.97
NO	0.0710	2.13	0.0019	0.06	0.0000	0.00
	5.5424	103.61	4.8760	100.03	4.8556	100.00 Total

Hydrazine - Perchloryl Fluoride

N_2H_4	%	40.5
ClO_3F	%	59.5
	%	
	%	

P_c 1000 psia	P_e	14.7	2.0	(psia)
T_c 3466 °K	T_e	1876	1236	°K
	ϵ	9.2	39.4	
	I_{sp}	295	332	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.0884	0.09	0.0006	0.00	0.0000	0.00
O	0.0203	0.32	0.0000	0.00	0.0000	0.00
F	0.0017	0.04	0.0000	0.00	0.0000	0.00
Cl	0.0660	2.34	0.0010	0.04	0.0000	0.00
H_2	0.3916	0.79	0.2050	0.41	0.2045	0.41
H_2O	1.4670	26.43	1.7417	31.38	1.7422	31.39
HCl	0.5141	18.75	0.5797	21.14	0.5807	21.18
HF	0.5791	11.59	0.5807	11.62	0.5807	11.62
O_2	0.0304	0.97	0.0000	0.00	0.0000	0.00
OH	0.1557	2.65	0.0004	0.01	0.0000	0.00
N_2	1.2444	34.87	1.2637	35.41	1.2637	35.41
NO	0.0384	1.08	0.0000	0.00	0.0000	0.00
Total	4.5977	99.92	4.3730	100.01	4.3719	100.01

Hydrazine - Chlorine Trifluoride

	%	
N_2H_4	%	27.0
ClF_3	%	73.0
	%	
	%	

P_c 1000 psia
T_c 3882 °K

P_e 14.7 — 2.0 (psia)
T_e 1798 — 1083 °K
ϵ 8.2 — 32.8
I_{sp} 293 — 325 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.1362	0.14	0.0002	0.00	0.0000	0.00
N	0.0003	0.00	0.0000	0.00	0.0000	0.00
F	0.0378	0.72	0.0000	0.00	0.0000	0.00
Cl	0.2392	8.48	0.0010	0.04	0.0000	0.00
H_2	0.1776	0.36	0.1062	0.21	0.1058	0.21
HCl	0.5476	19.97	0.7886	28.76	0.7896	28.80
HF	2.3306	46.64	2.3687	47.40	2.3687	47.40
N_2	0.8422	23.60	0.8425	23.61	0.8425	23.61
NH	0.0002	0.00	0.0000	0.00	0.0000	0.00
Cl_2	0.0012	0.08	0.0000	0.00	0.0000	0.00
ClF	0.0002	0.00	0.0000	0.00	0.0000	0.00
Total	4.3131	99.99	4.1072	100.02	4.1066	100.02

Hydrazine - Nitrogen Trifluoride

N_2H_4	%	23.0
NF_3	%	77.0
	%	
	%	

		P_e	14.7		2.0	(psia)
		T_e	1644		1040	°K
P_c	1000 psia	ϵ	7.4		30.6	
T_c	4202 °K	I_{sp}	305		337	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.0584	0.06	0.0000	0.00	0.0000	0.00
N	0.0010	0.01	0.0000	0.00	0.0000	0.00
F	0.4615	8.77	0.3778	7.18	0.2309	4.39
H_2	0.0103	0.02	0.0000	0.00	0.0000	0.00
HF	2.7915	55.86	2.8707	57.44	2.8707	57.44
N_2	1.2593	35.28	1.2599	35.30	1.2599	35.30
NH	0.0001	0.00	0.0000	0.00	0.0000	0.00
F_2	0.0001	0.00	0.0023	0.09	0.0758	2.88
Total	4.5823	100.00	4.5107	100.01	4.4372	100.01

UDMH - Hydrogen Peroxide

UDMH	%	18.0
H_2O_2	%	82.0
	%	
	%	

P_c 1000 psia
T_c 3002 °K

P_e 14.7 — 2.0 (psia)
T_e 1789 — 1270 °K
ϵ 9.8 — 45.1
I_{sp} 283 — 322 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.0152	0.02	0.0000	0.00	0.0000	0.00
O	0.0092	0.15	0.0000	0.00	0.0000	0.00
H_2	0.1340	0.27	0.0038	0.01	0.0000	0.00
H_2O	3.4001	61.26	3.6035	64.92	3.6086	65.01
CO	0.1314	3.68	0.0023	0.01	0.0000	0.00
CO_2	0.4675	20.57	0.5966	26.26	0.5990	26.36
O_2	0.0956	3.06	0.0094	0.30	0.0073	0.23
OH	0.1339	2.28	0.0026	0.04	0.0000	0.00
N_2	0.2894	8.11	0.2992	8.38	0.2995	8.39
NO	0.0203	0.61	0.0006	0.02	0.0000	0.00
Total	4.6966	100.01	4.5180	99.94	4.5144	99.99

UDMH - Fluorine

Propellant	%
UDMH	27.0
F_2	73.0

	Chamber	Exit	Exit
P	P_c 1000 psia	P_e 14.7	2.0 (psia)
T	T_c 4314 °K	T_e 2800	2146 °K
ϵ		10.4	49.5
I_{sp}		340	389 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.1096	0.11	0.0022	0.00	0.0000	0.00
C	0.0203	0.24	0.0000	0.00	0.0000	0.00
N	0.0006	0.01	0.0000	0.00	0.0000	0.00
F	0.4601	8.74	0.1929	3.66	0.0252	0.48
H_2	0.0254	0.05	0.0002	0.00	0.0000	0.00
HF	3.2980	65.99	3.5899	71.83	3.5939	71.91
N_2	0.2468	6.92	0.4434	12.42	0.4491	12.58
F_2	0.0001	0.00	0.0000	0.00	0.0000	0.00
CH	0.0005	0.01	0.0000	0.00	0.0000	0.00
CH_2	0.0012	0.00	0.0000	0.00	0.0000	0.00
CF	0.0281	0.87	0.0003	0.00	0.0000	0.00
CF_2	0.0195	0.98	0.0035	0.18	0.0003	0.02
CF_3	0.0052	0.36	0.0125	0.86	0.0140	0.97
CF_4	0.0001	0.01	0.0036	0.32	0.0451	3.97
CN	0.2890	7.52	0.0098	0.26	0.0002	0.01
C_2N_2	0.0088	0.46	0.0002	0.00	0.0000	0.00
C_2H_2	0.0176	0.46	0.0000	0.00	0.0000	0.00
CHF_3	0.0001	0.00	0.0000	0.00	0.0000	0.00
HCN	0.0975	2.64	0.0016	0.04	0.0000	0.00
NH	0.0001	0.00	0.0000	0.00	0.0000	0.00
C	0.3843	4.61	0.8668	10.41	0.8389	10.08
Total	5.0129	100.02	5.1269	99.98	4.9667	100.02

UDMH - OF_2

UDMH	%	28.0
OF_2	%	72.0
	%	
	%	

		P_e	14.7		2.0	(psia)
		T_e	2597		1715	°K
P_c	1000 psia	ϵ	9.6		40.8	
T_c	4458 °K	I_{sp}	351		397	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.4442	0.45	0.0404	0.04	0.0005	0.00
N	0.0014	0.02	0.0000	0.00	0.0000	0.00
O	0.1090	1.74	0.0010	0.02	0.0000	0.00
F	0.1629	3.10	0.0011	0.02	0.0000	0.00
H_2	0.2500	0.50	0.2483	0.50	0.2993	0.60
H_2O	0.0829	1.49	0.2573	4.64	0.2306	4.15
HF	2.5037	50.10	2.6655	53.33	2.6667	53.36
CO	0.8961	25.10	0.8004	22.42	0.7609	21.31
CO_2	0.0356	1.57	0.1314	5.78	0.1709	7.52
O_2	0.0148	0.47	0.0004	0.01	0.0000	0.00
OH	0.1126	1.92	0.0099	0.17	0.0000	0.00
N_2	0.4488	12.58	0.4654	13.04	0.4659	13.05
NO	0.0320	0.96	0.0010	0.03	0.0000	0.00
NH	0.0006	0.01	0.0000	0.00	0.0000	0.00
NH_2	0.0001		0.0000	0.00	0.0000	0.00
Total	5.0947	100.01	4.6221	100.00	4.5948	99.99

UDMH - Perchloryl Fluoride

UDMH	%	25.0
ClO_3F	%	75.0
	%	
	%	

P_c 1000 psia

T_c 3686 °K

P_e	14.7	2.0 (psia)
T_e	2328	1638 °K
ϵ	10.2	45.7
I_{sp}	289	329 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.0924	0.09	0.0066	0.01	0.0001	0.00
N	0.0001	0.00	0.0000	0.00	0.0000	0.00
O	0.0500	0.8	0.0004	0.01	0.0000	0.00
F	0.0060	0.11	0.0001	0.00	0.0000	0.00
Cl	0.1592	5.64	0.0276	0.98	0.0005	0.02
H_2	0.1886	0.38	0.0965	0.19	0.1294	0.26
H_2O	0.6907	12.44	0.8410	15.15	0.8026	14.46
HCl	0.5710	20.82	0.7042	25.68	0.7315	26.68
HF	0.7260	14.53	0.7320	14.65	0.7320	14.65
CO	0.5743	16.09	0.3238	9.07	0.2705	7.58
CO_2	0.2576	11.34	0.5082	22.36	0.5615	24.71
O_2	0.0728	2.33	0.0017	0.05	0.0000	0.00
OH	0.1797	3.06	0.0100	0.17	0.0000	0.00
N_2	0.3958	11.09	0.4154	17.64	0.4160	11.66
NO	0.0403	1.21	0.0011	0.03	0.0000	0.00
Cl_2	0.0009	0.06	0.0001	0.00	0.0000	0.00
	4.0054	99.99	3.6687	99.98	3.6441	100.02 Total

UDMH - Chlorine Trifluoride

UDMH	%	23.0
ClF_3	%	77.0
	%	
	%	

		P_e 14.7	2.0 (psia)
		T_e 1903	1381 °K
P_c	1000 psia	ϵ 8.9	40.9
T_c	3685 °K	I_{sp} 275	310 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.0325	0.03	0.0000	0.00	0.0000	0.00
C	0.0006	0.01	0.0000	0.00	0.0000	0.00
N	0.0001	0.00	0.0000	0.00	0.0000	0.00
F	0.0545	1.03	0.0003	0.01	0.0000	0.00
Cl	0.3538	12.54	0.1546	5.48	0.0188	0.67
H_2	0.0244	0.04	0.0000	0.00	0.0000	0.00
HCl	0.4685	17.09	0.5850	21.33	0.7155	26.09
HF	2.4376	48.78	2.4765	49.55	2.3460	46.94
N_2	0.3250	9.11	0.3827	10.72	0.3827	10.72
Cl_2	0.0048	0.34	0.0465	3.30	0.0492	3.49
ClF	0.0009	0.05	0.0001	0.01	0.0000	0.00
CH_2	0.0003	0.00	0.0000	0.00	0.0000	0.00
CF	0.0011	0.03	0.0000	0.00	0.0000	0.00
CF_2	0.0013	0.05	0.0000	0.00	0.0000	0.00
CF_3	0.0005	0.03	0.0004	0.03	0.0000	0.00
CN	0.0494	1.28	0.0000	0.00	0.0000	0.00
C_2N_2	0.0028	0.14	0.0000	0.00	0.0000	0.00
C_2H_2	0.0065	0.17	0.0000	0.00	0.0000	0.00
HCN	0.0603	1.63	0.0000	0.00	0.0000	0.00
C (solid)	0.6332	7.60	0.7599	9.13	0.7273	8.74
CF_4	0.0000	0.00	0.0050	0.44	0.0381	3.35
	3.8251	99.95	3.6513	100.00	3.5504	100.01 Total

UDMH - Nitrogen Trifluoride

UDMH	%	28.0
NF_3	%	72.0
	%	
	%	

P_c 1000 psia

T_c 3749 °K

P_e	14.7	2.0 (psia)
T_e	1977	1295 °K
ϵ	9.1	39.0
I_{sp}	303	341 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.0973	0.10	0.0017	0.00	0.0000	0.00
N	0.0002	0.00	0.0000	0.00	0.0000	0.00
F	0.0366	0.70	0.0000	0.00	0.0000	0.00
H_2	0.1450	0.29	0.3362	0.68	0.3424	0.69
HF	3.0033	60.10	3.0419	60.87	3.0419	60.87
N_2	0.7904	22.15	0.9675	27.11	0.9728	27.26
CH	0.0001	0.00	0.0000	0.00	0.0000	0.00
CH_2	0.0024	0.03	0.0000	0.00	0.0000	0.00
CF	0.0008	0.02	0.0000	0.00	0.0000	0.00
CF_2	0.0004	0.02	0.0000	0.00	0.0000	0.00
CF_3	0.0001	0.01	0.0000	0.00	0.0000	0.00
CN	0.1031	2.68	0.0000	0.00	0.0000	0.00
C_2N_2	0.0080	0.42	0.0000	0.00	0.0000	0.00
C_2H_2	0.0430	1.12	0.0002	0.00	0.0000	0.00
HCN	0.2455	6.64	0.0107	0.28	0.0002	0.00
NH	0.0001	0.00	0.0000	0.00	0.0000	0.00
C (solid)	0.4765	5.72	0.9206	11.06	0.9316	11.19
Total	4.9527	100.00	5.2788	100.00	5.2887	100.01

Hydrogen - Oxygen

H_2	%	24.0
O_2	%	76.0
	%	
	%	

	Chamber		Exit		Exit	
P_c	1000	psia	P_e	14.7	2.0	(psia)
T_c	2570	°K	T_e	1059	646	°K
			ϵ	7.7	31.1	
			I_{sp}	389	431	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.0379	0.04	0.0000	0.00	0.0000	0.00
H_2	7.1387	14.39	7.1548	0.00	7.1548	0.00
H_2O	4.7442	85.47	4.7500	14.42	4.7500	14.42
OH	0.0058	0.10	0.0000	85.58	0.0000	85.58
Total	11.9266	100.00	11.9048	100.00	11.9048	100.00

Hydrogen - Hydrogen Peroxide

H_2	%	10.5
H2O2	%	89.5
	%	
	%	

			P_e	14.7	2.0	(psia)
			T_e	1164	744	^oK
P_c	1000	psia	ϵ	8.2	34.6	
T_c	2567	^oK	I_{sp}	322	359	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %	
H	0.0182	0.02	0.0000	0.00	0.0000	0.00	
H_2	2.5725	5.19	2.5772	5.20	2.5772	5.20	
H_2O	5.2536	94.65	5.2622	94.80	5.2622	94.80	
OH	0.0085	0.14	0.0000	0.00	0.0000	0.00	
	7.8528	100.00	7.8394	100.00	7.8394	100.00	Total

Hydrogen - Fluorine

H_2	%	8.0
F_2	%	92.0
	%	
	%	

	Chamber		Exit		Exit (optimum)	
P_c	1000 psia	P_e	14.7		2.0	(psia)
T_c	4462 °K	T_e	2396		1500	°K
		ϵ	9.0		36.9	
		I_{sp}	407		457	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	1.0934	1.10	0.0486	0.05	0.0002	0.00
F	0.1726	3.28	0.0002	0.00	0.0000	0.00
H_2	1.0868	2.19	1.5230	3.07	1.5471	3.12
HF	4.6695	93.43	4.8419	96.88	4.6421	92.88
Total	7.0223	100.00	6.4137	100.00	6.1894	96.00

Hydrogen - OF_2

H_2	%	14.5
OF_2	%	85.5
	%	
	%	

P_c 1000 psia		P_e	14.7	2.0	(psia)
T_c 3591 °K		T_e	1663	1022	°K
		ϵ	8.2	33.4	
		I_{sp}	411	457	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.5141	0.52	0.0006	0.00	0.0000	0.00
O	0.0077	0.12	0.0000	0.00	0.0000	0.00
F	0.0064	1.12	0.0000	0.00	0.0000	0.00
H_2	3.8318	7.72	4.0255	8.12	4.0258	8.12
H_2O	1.4735	26.55	1.5833	28.52	1.5833	28.52
HF	3.1603	63.23	3.1667	63.36	3.1667	63.36
O_2	0.0012	0.04	0.0000	0.00	0.0000	0.00
OH	0.0998	1.70	0.0000	0.00	0.0000	0.00
	9.0948	100.00	8.7761	100.00	8.7758	100.00 Total

Hydrogen - Perchloryl Fluoride

H_2	%	11.0
ClO_3F	%	89.0
	%	
	%	

			P_e	14.7	2.0	(psia)
			T_e	1656	1071	°K
P_c	1000	psia	ϵ	8.6	36.3	
T_c	3369	°K	I_{sp}	341	382	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.1971	0.20	0.0003	0.00	0.0000	0.00
O	0.0064	0.10	0.0000	0.00	0.0000	0.00
F	0.0010	0.02	0.0000	0.00	0.0000	0.00
Cl	0.0466	1.65	0.0001	0.00	0.0000	0.00
H_2	1.9756	3.98	1.9816	3.99	1.9817	4.00
H_2O	2.4818	44.71	2.6059	46.95	2.6060	46.95
HCl	0.8218	29.97	0.8686	31.67	0.8686	31.67
HF	0.8677	17.36	0.8686	17.38	0.8686	17.38
O_2	0.0032	0.10	0.0000	0.00	0.0000	0.00
OH	0.1112	1.89	0.0000	0.00	0.0000	0.00
Cl_2	0.0001	0.01	0.0000	0.00	0.0000	0.00
Total	6.5125	99.99	6.3251	99.99	6.3249	100.00

Hydrogen - Chlorine Trifluoride

H_2	%	6.5
ClF_3	%	93.5
	%	
	%	

			P_e	14.7		2.0	(psia)
			T_e	1601		947	°K
P_c	1000	psia	ϵ	7.9		30.9	
T_c	3690	°K	I_{sp}	318		352	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %	
H	0.2664	0.27	0.0001	0.00	0.0000	0.00	
F	0.0120	0.23	0.0000	0.00	0.0000	0.00	
Cl	0.1191	4.22	0.0001	0.00	0.0000	0.00	
H_2	1.1344	2.29	1.2016	2.42	1.2016	2.42	
HCl	0.8914	32.50	1.0112	36.87	1.0113	36.88	
HF	3.0218	60.46	3.0338	60.70	3.0338	60.70	
Cl_2	0.0004	0.03	0.0000	0.00	0.0000	0.00	
	5.4455	100.00	5.2468	99.99	5.2467	100.00	Total

Hydrogen - Nitrogen Trifluoride

H_2	%	5.5
NF_3	%	94.5
	%	
	%	

P_c 1000 psia

T_c 4212 °K

P_e 14.7 | 2.0 (psia)

T_e 1969 | 1185 °K

ϵ 8.3 | 32.8

I_{sp} 351 | 390 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.4796	0.48	0.0026	0.00	0.0000	0.00
N	0.0009	0.01	0.0000	0.00	0.0000	0.00
F	0.1015	1.93	0.0000	0.00	0.0000	0.00
H_2	0.5424	1.09	0.7306	1.47	0.7319	1.48
HF	3.8910	77.85	3.9925	79.88	3.9925	79.88
N_2	0.6646	18.62	0.6654	18.64	0.6654	18.64
NH	0.0007	0.01	0.0000	0.00	0.0000	0.00
NH_2	0.0002	0.00	0.0000	0.00	0.0000	0.00
Total	5.6809	99.99	5.3911	99.99	5.3898	100.00

Hydrogen - Nitrogen Tetroxide

H_2	%	13.0
N_2O_4	%	87.0
	%	
	%	

		P_e	14.7	2.0	(psia)
		T_e	1392	889	°K
P_c	1000 psia	ϵ	8.3	34.9	
T_c	3029 °K	I_{sp}	341	381	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.0926	0.09	0.0000	0.00	0.0000	0.00
O	0.0010	0.02	0.0000	0.00	0.0000	0.00
H_2	2.6478	5.34	2.6664	5.38	2.6663	5.38
H_2O	3.7307	67.21	3.7820	68.14	3.7820	68.14
O_2	0.0006	0.02	0.0000	0.00	0.0000	0.00
OH	0.0462	0.79	0.0000	0.00	0.0000	0.00
N_2	0.9438	26.44	0.9455	26.49	0.9454	26.49
NO	0.0029	0.09	0.0000	0.00	0.0000	0.00
NH_2	0.0001	0.00	0.0000	0.00	0.0000	0.00
NH_3	0.0002	0.00	0.0000	0.00	0.0001	0.00
Total	7.4659	100.00	7.3939	100.01	7.3938	100.01

Pentaborane - Oxygen

	%	
B_5H_9	%	38.0
O_2	%	62.0
	%	
	%	

P_c 1000 psia
T_c 3772 °K

P_e	14.7	2.0	(psia)
T_e	2498	2030	°K
ϵ	10.5	53.0	
I_{sp}	316	364	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.3917	0.39	0.0784	0.08	0.0169	0.02
B	0.0170	0.18	0.0003	0.00	0.0000	0.00
O	0.0002	0.00	0.0000	0.00	0.0000	0.00
H_2	2.1007	4.24	2.3270	4.69	2.3688	4.78
H_2O	0.0198	0.36	0.0024	0.04	0.0007	0.01
OH	0.0021	0.04	0.0000	0.00	0.0000	0.00
BO	0.3237	8.68	0.0334	0.90	0.0039	0.10
B_2O_2	0.8575	46.00	0.9601	51.50	0.8067	43.27
B_2O_3	0.0865	6.02	0.1886	13.13	0.3138	21.85
HBO_2	0.7772	34.06	0.6765	29.65	0.6578	28.83
BH	0.0016	0.02	0.0000	0.00	0.0000	0.00
B (solid)	0.0000	0.00	0.0000	0.00	0.1049	1.14
Total	4.5780	99.99	4.2667	99.99	4.2735	100.00

Pentaborane - Hydrogen Peroxide

B_5H_9	%	40.0
H_2O_2	%	60.0
	%	
	%	

	P_e 14.7	2.0	(psia)
	T_e 2051	1825	°K
P_c 1000 psia	ϵ 11.4	61.1	
T_c 2685 °K	I_{sp} 303	354	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.0310	0.03	0.0108	0.01	0.0056	0.01
H_2	4.0552	8.18	4.3814	8.83	4.4834	9.04
H_2O	0.0121	0.22	0.0014	0.02	0.0005	0.00
BO	0.0072	0.19	0.0009	0.02	0.0002	0.00
B_2O_2	0.3675	19.71	0.1809	9.70	0.0898	4.82
B_2O_3	0.1146	7.98	0.0723	5.03	0.0430	2.99
HBO_2	1.0606	46.48	0.4500	19.72	0.2532	11.10
B_2O_3 (liquid)	0.1027	7.15	0.6822	47.51	0.9040	62.95
B (liquid)	0.9284	10.04	0.0000	0.00	0.0000	0.00
B (solid)	0.0000	0.00	0.8442	9.13	0.8389	9.08
Total	5.6484	99.98	5.0977	99.97	4.8756	99.99

Pentaborane - Fluorine

	%	
B_5H_9	%	20.0
F_2	%	80.0
	%	
	%	

P_c 1000 psia
T_c 4991 ^oK

P_e	14.7	2.0 (psia)
T_e	3105	2532 ^oK
ϵ	9.9	49.1
I_{sp}	358	409 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.6675	0.67	0.2436	0.24	0.1120	0.11
B	0.0022	0.02	0.0000	0.00	0.0000	0.00
F	0.4208	8.00	0.0114	0.22	0.0008	0.02
H_2	0.1610	.32	0.3107	0.62	0.5245	1.06
HF	1.8599	37.22	1.9844	39.71	1.6883	33.78
BF	1.3274	39.58	1.1748	35.03	1.0144	30.25
BF_2	0.1577	7.70	0.1846	9.01	0.1987	9.70
BF_3	0.0956	6.48	0.2236	15.16	0.3698	25.08
	4.6921	99.99	4.1331	99.99	3.9085	100.00 Total

Pentaborane - OF_2

B_5H_9	%	18.5
OF_2	%	81.5
	%	
	%	

P_c 1000 psia	P_e	14.7	2.0	(psia)
T_c 5215 °K	T_e	3567	2970	°K
	ϵ	10.6	53.6	
	I_{sp}	366	422	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.8985	0.90	0.6263	0.63	0.4094	0.41
B	0.0015	0.01	0.0000	0.00	0.0000	0.00
O	0.2543	4.07	0.0564	0.90	0.0120	0.19
F	0.3643	6.92	0.0644	1.22	0.0126	0.24
H_2	0.1875	0.38	0.2116	0.43	0.2924	0.59
H_2O	0.0222	0.40	0.0229	0.41	0.0311	0.56
HF	1.2067	24.15	1.4967	29.95	1.5521	31.06
O_2	0.0121	0.19	0.0024	0.04	0.0005	0.01
OH	0.0999	1.70	0.0333	0.57	0.0142	0.24
BF	0.3383	10.09	0.0763	2.28	0.0237	0.71
BF_2	0.0207	1.01	0.0045	0.22	0.0016	0.08
BF_3	0.0062	0.42	0.0018	0.12	0.0009	0.06
BOF	1.0491	48.07	1.3666	62.62	1.4243	65.26
BO	0.0370	0.99	0.0046	0.12	0.0009	0.02
B_2O_2	0.0001	0.00	0.0000	0.00	0.0000	0.00
HBO_2	0.0111	0.49	0.0103	0.45	0.0128	0.56
Total	4.4984	99.79	3.9781	99.96	3.7885	99.99

Pentaborane - Perchloryl Fluoride

B_5H_9	%	23.0
ClO_3F	%	77.0
	%	
	%	

P_c 1000 psia
T_c 4254 °K

P_e	14.7	2.0	(psia)
T_e	2821	2301	°K
ϵ	10.4	52.6	
I_{sp}	303	349	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.5079	0.51	0.1604	0.16	0.0492	0.05
B	0.0063	0.07	0.0003	0.00	0.0000	0.00
O	0.0062	0.10	0.0000	0.00	0.0000	0.00
F	0.0004	0.01	0.0000	0.00	0.0000	0.00
Cl	0.1838	6.52	0.0611	2.17	0.0190	0.07
H_2	0.8002	1.61	0.9744	1.96	1.0436	2.10
H_2O	0.0399	0.72	0.0053	0.10	0.0014	0.02
HCl	0.5080	18.53	0.6522	23.78	0.7058	25.74
HF	0.0227	0.45	0.0030	0.06	0.0008	0.02
O_2	0.0001	0.00	0.0000	0.00	0.0000	0.00
OH	0.0179	0.30	0.0003	0.00	0.0000	0.00
Cl_2	0.0004	0.03	0.0000	0.00	0.0000	0.00
BCl	0.0173	0.80	0.0076	0.35	0.0033	0.15
BCl_2	0.0010	0.08	0.0010	0.08	0.0010	0.08
BCl_3	0.0001	0.01	0.0004	0.04	0.0011	0.13
BF	0.1700	5.07	0.1299	3.87	0.0957	2.85
BF_2	0.0002	0.01	0.0000	0.00	0.0000	0.00
BFCl	0.0009	0.06	0.0003	0.02	0.0002	0.01
$BFCl_2$	0.0001	0.01	0.0001	0.01	0.0001	0.01
BOCl	0.0380	2.37	0.0269	1.67	0.0176	1.10
BOF	0.5569	25.52	0.6182	28.33	0.6546	29.99
BO	0.2525	6.77	0.0569	1.53	0.0117	0.31
B_2O_2	0.0922	4.94	0.1718	9.22	0.1987	10.66
B_2O_3	0.0262	1.82	0.0669	4.66	0.1032	7.10
HBO_2	0.5399	23.66	0.5013	21.97	0.4310	18.89
Total	3.7891	99.97	3.4383	99.98	3.3380	99.95

Pentaborane - Chlorine Trifluoride

B_5H_9	%	11.0
ClF_3	%	89.0

P_c	1000 psia	P_e	14.7	2.0	(psia)
T_c	4542 ^oK	T_e	3007	2555	^oK
		ϵ	10.3	52.5	
		I_{sp}	290	332	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.1325	0.13	0.0430	0.04	0.0235	0.02
B	0.0001	0.00	0.0000	0.00	0.0000	0.00
F	0.2176	4.13	0.0109	0.21	0.0018	0.03
Cl	0.6771	24.01	0.4578	16.23	0.3014	10.69
H_2	0.0272	0.06	0.0248	0.05	0.0275	0.05
HCl	0.2430	8.86	0.4638	16.91	0.6191	22.58
HF	1.1372	22.76	1.0107	20.22	0.8696	17.40
Cl_2	0.0038	0.27	0.0011	0.08	0.0005	0.04
ClF	0.0015	0.08	0.0000	0.00	0.0000	0.00
BCl	0.0006	0.03	0.0000	0.00	0.0000	0.00
BCl_2	0.0001	0.00	0.0000	0.00	0.0000	0.00
BF	0.4488	13.38	0.2901	8.65	0.2218	6.61
BF_2	0.1422	6.94	0.1237	6.04	0.1087	5.31
BF_3	0.2478	16.80	0.4201	28.49	0.5012	33.99
BFCl	0.0057	0.37	0.0029	0.19	0.0020	0.13
BF_2Cl	0.0238	2.00	0.0318	2.68	0.0348	2.93
$BFCl_2$	0.0014	0.14	0.0019	0.19	0.0021	0.21
Total	3.3104	99.96	2.8816	99.98	2.7122	99.99

Pentaborane - Nitrogen Trifluoride

B_5H_9	%	13.0
NF_3	%	87.0
	%	
	%	

P_c 1000 psia
T_c 4809 °K

P_e	14.7	2.0 (psia)
T_e	3155	2501 °K
ϵ	10.2	50.0
I_{sp}	326	373 sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.2360	0.24	0.0988	0.10	0.0499	0.05
B	0.0004	0.00	0.0000	0.00	0.0000	0.00
N	0.0039	0.05	0.0000	0.00	0.0000	0.00
F	0.4776	9.07	0.0285	0.54	0.0009	0.02
H_2	0.0366	0.07	0.0460	0.09	0.1608	0.32
HF	1.5422	30.86	1.6614	33.24	1.4806	29.63
N_2	0.6104	17.10	0.6126	17.16	0.6126	17.16
NH	0.0005	0.00	0.0000	0.00	0.0000	0.00
BF	0.6318	18.84	0.4717	14.07	0.3757	11.20
BF_2	0.1664	8.12	0.1576	7.69	0.1413	6.90
BF_3	0.2304	15.62	0.3996	27.09	0.5119	34.72
Total	3.9362	99.97	3.4762	99.98	3.3337	100.00

Pentaborane - Nitrogen Tetroxide

B_5H_9	%	24.5
N_2O_4	%	75.5
	%	
	%	

P_c 1000 psia
T_c 4115 °K

P_e	14.7	2.0	(psia)
T_e	2722	2184	°K
ϵ	10.4	52.5	
I_{sp}	304	350	sec optimum

Combustion Gases	mol/100g	wt %	mol/100g	wt %	mol/100g	wt %
H	0.4302	0.43	0.1224	0.12	0.0286	0.03
B	0.0037	0.04	0.0001	0.00	0.0000	0.00
N	0.0006	0.01	0.0000	0.00	0.0000	0.00
O	0.0054	0.09	0.0000	0.00	0.0000	0.00
H_2	0.8693	1.75	1.0930	2.20	1.1883	2.40
H_2O	0.0603	1.09	0.0101	1.82	0.0028	0.50
O_2	0.0002	0.00	0.0000	0.00	0.0000	0.00
OH	0.0199	0.34	0.0003	0.00	0.0000	0.00
N_2	0.8179	22.92	0.8205	22.99	0.8205	22.99
NO	0.0036	0.11	0.0000	0.00	0.0000	0.00
BO	0.2671	7.16	0.0411	1.10	0.0051	0.14
B_2O_2	0.1666	8.94	0.1972	10.58	0.1668	8.95
B_2O_3	0.0777	5.41	0.1711	11.92	0.2604	18.13
HBO_2	1.1795	51.70	1.1614	50.90	1.0796	47.32
NH	0.0008	0.00	0.0000	0.00	0.0000	0.00
NH_2	0.0002	0.00	0.0000	0.00	0.0000	0.00
BH	0.0002	0.00	0.0000	0.00	0.0000	0.00
Total	3.9032	100.00	3.6172	101.63	3.5521	100.46

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Performance tables are presented which were obtained by plotting data from machine calculations and interpolating to obtain vacuum specific impulses for integral values of the area ratio. The values are convenient reference points for the calculation of interpolated values of the specific impulse for any given area ratio. Tables of gas compositions and performances are also included in this handbook.

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